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SCIENTIFIC REPORTING.

A FEW weeks ago some specimens of an incandescent lamp were submitted for test to a gentleman whose name it is needless to mention. It was claimed that the new lamp, which is said to be outside the Edison-Swan patents, was also considerably less wasteful of electrical energy per candle-power than those now holding the monopoly of incandescent electric lighting. The lamps to which we refer were labelled for certain voltages, and in the table below the details of the experiments, which we have every reason to believe are correct, may be seen:—

Lamp Mark.	Actual Volts.	Current.	Candle-power.
98	98	·600 ampère	13·4
110	110	·525	12·7
106	106	·600	12·7
90	90	·800	14·13

We may incidentally mention that several samples of the lamp, which do not seem to possess much uniformity, probably on account of imperfections in a new manufacture, were also submitted to the same expert so long ago as last October, labelled 100 volts 16 candle-power; but it was found that to bring them up to this luminosity required in the respective instances 104 to 106 volts. Being thus over-run, the result reduced to watts per candle-power showed a slight saving over the electrical energy generally assumed to be required in an Edison lamp incandesced to the same degree.

We believe it is safe to say that 60 watts for a 16 candle-power lamp is a maximum for any really good manufacture. Many makers or consumers would doubtless say—and if they feel convinced we allow too great margin we hope they will say—that 50 watts is nearer the mark, at all events when the filaments are first put into operation, the difference between old lamps and new in this respect being too well known to need further discussion.

This being so we wish to bring before the notice of our readers the report of a Professor of high renown, with every convenience at hand for conducting the tests on the most scientific lines, and who, we believe, enjoys the confidence of the public in no ordinary degree. The lamps he was requested to examine were, we understand, selected from the same batch as those figuring in the above table, and this is his verdict after a comparison with Edison-Swan lamps:—"X's lamps consumed 3·12 watts per candle-power, Edison-Swan 4·29 watts per candle-power, thus proving that X's show an effective saving of 25 per cent."

Our readers will not fail to notice that there is no reference here to the voltage and measured candle-power of either X's lamps or those of Edison-Swan, therefore we need not question the intelligence of those who have even a slight acquaintance with lamp tests by commenting upon the value of such figures; but upon examination of the foregoing table it will be seen that in X's lamps the labelled voltage in no case brought up the degree of incandescence to 16 candles, a result in conformity with previous tests. Calculating from these the electrical energy consumed it will be seen that instead of showing a saving of 25 per cent. over the Edison-Swan, X's lamps, they all demanded even more than those, probably old and half worn out, which came under the notice of the Professor.

Now we ask, is it fair to the owners of X's lamp patents, to the public, who will doubtless eventually read the report, to the electrical trades, and particularly to the Edison-Swan Company, to give such a vague, misleading, and absolutely valueless statement as that which we quote? By overrunning we may make the watts per candle-power almost as low as we like, short of the breaking limit, or as uneconomical as needs be if working below the normal difference of potential at the lamp terminals, and the knowledge of a few simple facts like these would save much time, expense, and disappointed hopes alike to both financiers and inventors.

We almost feel inclined to offer to carry out a series of tests ourselves, and publish the results if makers would submit their lamps to our examination; we would

at least test them under proper conditions, and give the necessary data from which experts and the public could form their own conclusions. Perhaps some of our readers will kindly favour us with some incandescent lamp figures as they exist at the present day?

A CHALLENGE.

THE meeting of the Tramways Institute of Great Britain, which is discussed on another page, was, to the electrical fraternity, of interest only for the argument which took place on the score of electric traction. We need not here reproduce any of the points at issue, for they are fully set forth in their proper place; but we cannot let the matter slumber without an effort to revive so important and interesting a controversy. In our last issue we referred to the Elieson system as costing nearly three times the amount of the contract price per car mile, viz., 4½d., and we have now every reason to believe that the cost of electric traction on the Barking line is something like twice the contract figure. Data in our possession point to this result, and Mr. Willbond's assertions bear out to a great extent the likelihood of their accuracy; we cannot, however, at the moment publish them in detail, but we do challenge the General Electric Power and Traction Company, Limited, to bear out the statements which, on the authority of their managing director, appeared on page 72 of the REVIEW for January 17th of this year, when it was asserted that the working of the Barking line had shown it to be operated at a profit. This becomes all the more necessary when it is remembered that the Barking line formed one of the valuable properties for which the sum of £242,000 was modestly asked (*vide* articles on *Traction*, ELECTRICAL REVIEW for May 23rd and June 6th).

There is at the present moment too great a tendency to float companies, utterly irrespective of the merits of the structure on which they are based, and we feel, therefore, that it is best to be outspoken, for truth, like murder, will out, and there is no good in mincing matters at a crisis.

It is folly to work a line and pretend to be making a profit if the expenses are double the receipts; the only frank course to pursue is to state the actual facts, and then to seek for the means of reducing the working cost until traction by electrical energy can compete on its own bottom with the present means of tramcar propulsion.

Perpetual Motion Realised at Last.

A CORRESPONDENT sends us the following delightful cutting from the *English Mechanic*, which, with the electrophonoscope, we strongly recommend to the notice of enterprising company promoters. In either case it would be unnecessary to tell off an expert to examine into the stability of the business or the probity of those connected with the respective schemes:—

I wish to light my house with electricity, and it has struck me that I might do so without the aid of an engine. If I were to use two dynamos, starting one of them by hand, and using half of the current that I got from it to drive the other as a motor, letting the other half light the lamps, the motor would then be used for driving dynamo No. 1. I should be much obliged if you would tell me (1) if this has been tried before?—and if not, could I take out a patent for it, as it is entirely my own idea? 2. How much wire should I put on each of the dynamos to light 20 8-volt lamps (not arc lamps)? And is it necessary to have the armature of iron, or would brass do as well? As I am very anxious to become an electrician proper, could you recommend any firm that would allow me to work for a few months in their shops, for which I would give my services, that I might get an insight into the practical work, as I understand the theory of the thing pretty well?—A WOULD-BE ELECTRICIAN.

Perhaps the best testimonial which this "Would-be-Electrician" could offer to a business firm is his self-made assertion that he "understands the theory of the thing pretty well."

Taking the Lead of America.

How Prof. Hughes and Mr. Preece must have chuckled over their huge Electrophonoscopic joke. It is not given to the lesser lights of science to conceive, much less to carry out, such an elaborate delusion which, it is not too much to say, has set the whole civilised world by the ears. Prof. Pepper, of Polytechnic fame, years ago devised many very clever optical illusions and he was looked upon as a scientific nobody; but it has been reserved for this age of enlightenment to laud to the skies the reproduction of an old trick with which every schoolboy is supposed to be familiar. "At last, it seems, says *Life*, "we have taken the lead of America in producing a triumph of electrical invention. To be able to see and converse with a friend on the other side of the Channel, for instance, will be an achievement that will simply abolish all the anxiety of absence and all the sorrow of parting. The 'Electrophonoscope' is certainly a marvellous advance in a science which of late years has made such giant strides, and it is most gratifying to know that we are indebted for it to the genius of two of our own countrymen." We fear *Life* does not know much of the subject upon which it treats. Fancy after getting rid of a "friend," one fondly hopes for ever, to be electrophonoscopically bothered by his presence from across the Channel! Luckily we are not likely to suffer any such misfortune until the Channel tunnel is constructed; then, if our two countrymen are still in existence and in full possession of their faculties, Heaven help us.

Increasing Locomotive Traction by Electricity.

THIS subject is one which continues to excite interest in America; it is undoubtedly an important one in view of the adoption of electric locomotion with light vehicles. Mr. Elias E. Ries, whose experiments on the subject have been questioned as to their practical accuracy, are stated by Mr. C. Selden, in a paper read before the Railway Telegraph Superintendents' Convention in America, to be correct, as the result of experiments he has made. Certainly, according to the tests made with a model motor, the passage of a current between the wheels and rail, whether the latter were clean and bright, or highly greasy, increased the adhesion to a very marked extent. These results, it may be recollected, do not at all accord with experiments recently described in our pages; to what is this discrepancy owing? Mr. Selden, in his paper, admits that practical tests alone can determine whether sufficient power can be had from a proper dynamo and auxiliary engine to show even an increase of 25 per cent. in the adhesion in the case of a full sized locomotive. In fact, the question seems to be, to a great extent, whether the power required to give the adhesion may not be more profitably employed in increasing the power of the motor driving the engine, the latter being

more heavily weighted. It is stated that Mr. Ries is making arrangements for a trial which will determine conclusively the real value of the idea; the results of this trial will be awaited with interest, although we do not anticipate that an approach to electric welding in this form will prove advantageous. Adhesion between wheels and track must be obtained by some more simple method, for this can only be looked upon as a sheer waste of electrical energy at best.

The Overhead Wires Bill.

A VALUED correspondent thinks our remarks last week on the overhead telegraph lines are not quite right. He points out that the Bill as it originally stood was one for the formation of subways in all streets, to compel gas, water, and electric companies to move their mains at their own cost into these subways, and afterwards pay a very high rent charge for the use of them. To those people who had already worked out a system of culverts, which are practically subways placed in the most handy position for serving the houses, the proposal was, of course, a very serious one; but at an early stage the subway clauses were abandoned, and the Bill was confined to the question of the regulation of overhead wires. Here is the point on which our correspondent falls foul, for he considers it would have been, and we think with reason, manifestly unjust to have compelled all the existing companies to place their wires underground at great cost, and then for the London County Council to issue licenses to rivals to carry on a complete system of overhead wires to serve identically the same district, and thus introduce an extremely unfair competition. Still, he thinks that even had the Bill passed through, the committee would have seen this unfairness, and restrained the County Council from giving such licenses where the district was already well served by subterranean conductors, and restricted the license to existing companies for the purpose of trunk lines to serve outlying parts or for scattered customers in thinly-populated portions of their area. Had such a contingency been provided for, our correspondent believes the Bill would have met the hearty support of those, himself included, who opposed it.

Overhead Wires. A Householder's Views.

COMING nearer home our friend confesses that, as a house owner who had given permission for the erection of telephone poles and wires on his residence, he has a heartfelt sympathy with the speakers in the House of Commons who complained of the annoyance caused by the workmen who have to enter houses for the purpose of attending to the wires. "The British workman," quoting the writer's remarks, "is bad enough to manage when he is your own servant, but when he is not under your control his behaviour is such that it increases the discomforts of housekeeping enormously. The one subject of stair carpets is a perfectly correct one to mention. It must be admitted that a great deal of the domestic happiness of the average householder depends on the comfort and good temper of his servants, and I assure you that the tempers of the best of servants can be ruined by allowing workmen to tramp up and down stairs at all frequently. In all well regulated households the domestics do their work at certain hours, the house is cleaned down at a certain time, and if workmen come in after these hours and dirty the stairs and passages, as they invariably do, the equanimity of the servants is disturbed for the whole of the day. It is perfectly true also about thefts. It may be that the workmen are perfectly honest, but they become the 'cat' responsible for all breakages and robberies which may have been committed by the servants themselves." He concludes as follows:—"If overhead wires are to be regulated and permitted, and attachments made compulsory, I am quite certain that the companies will have to maintain an outside ladder for the purpose of giving access to them, and that such outside ladders ought to be fixed much more frequently than is at present the case. They would act very effectually as fire escapes, and might be insisted upon with great advantage by the County Council. It should be fixed in a convenient situation at the back of the house in such a manner that it can be used as a fire escape, and provided with a gate or door at the bottom, so that it can be opened from the inside by anybody escaping, but would not be accessible to thieves or to anyone but the people owning the house or the officials of the overhead wire company." We cannot but think that the idea of the ladder is not happy so far as protection from burglars is concerned. Let our friend imagine a thief in his house, entering from the front, and, being disturbed, escaping by means of the very apparatus (opening it from the inside), which is intended to save life and defeat the ends of midnight prowlers.

Prospectus Making.

HAD time and space allowed of such a course, we might have spoken last week at still greater length on the prospectus of the Okonite Company. In comparing its uncertain future with the present condition of the Silvertown and Telegraph Construction and Maintenance Companies, it must have been overlooked by the promoters that the profits of the latter powerful organisation are derived from the manufacture of goods which have nothing in common with okonite, and, although the reputation of the Silvertown leads is deservedly high, the profits from this source probably form a very insignificant part of those accruing from the whole undertaking. If, on the other hand, equally deserving firms had been cited, such as Henleys, the Helsby Company, Messrs. Walter T. Glover & Co., the London Electric Wire Company, &c., no such profits have been made, and as okonite must compete with the productions of these firms, it would have been only fair to have at least mentioned them. Moreover, to one who knows how difficult it is, and the unremitting care and attention required to work up a turnover in electric lighting with sufficient to pay a fair dividend, even on a modest capital, the task of attempting so to do on a sum of £440,000 appears stupendous. We should look upon the managing director who could successfully perform such a feat with respectful admiration.

The Rival Systems.

WE shall be greatly interested to see what is said further on the subject of our last week's leaderette. It must be of great value to the trade in general to have the matter ventilated, and we do not for a moment think there is nothing to be said on the side of the alternating current system; but hitherto the companies using it have been remarkably chary in saying it, and if they do not come forward with explanations it is more than likely that a very bad impression will be made. It may further be pointed out that the balance sheets of a good many companies have been published, and in all cases the engine room costs of the alternating current appear to be excessively high, and hitherto no attempt has been made to explain them.

ON DESIGNING SWITCHES FOR ELECTRIC PLANTS.*

By OLOF OFFRELL.

IN the early days of electric lighting very little attention was paid to the accessories of an electric installation, and especially to the devices known as switches. Naturally enough, as long as the dynamo and the lamp were in a primitive state, and, consequently, there was a great field for improvement in that direction, so long no attention would be given to less important matters, mere details, although quite important ones after all.

Only within the last two or three years have inventors turned their attention toward perfecting the switch, which has now become a *sine qua non* in almost every kind of electric installation; but we have now very ingenious and practical devices of this kind in the market.

The purpose of this article is to give some practical points on designing switches, brought out by experience.

One of the first points to consider in designing a switch is its capacity, that is, how many ampères of current it can safely carry over and through its contacts without appreciable heating. On this point there seems to exist a great difference of opinion. Not any two switches of the same rated capacity have approximately, or anywhere near approximately, equal contact surface. While a large contact surface is a decided advantage, we soon reach a limit, which we cannot pass without materially increasing the size and consequently the cost of the switch, and then the question arises—what is the smallest allowable contact surface in square inches per ampère to be carried that we can use with a factor of safety large enough to prevent any appreciable heating? The writer has found 0·01 square inch surface per ampère to be a good rule, below which it is not advisable to go. In arc light or constant current switches, which generally do not carry over 10 ampères, we can, and usually do, make the contacts a good deal larger, from 2 to 4 times, as we are here not so much restricted by a bulky appearance and cost as is the case with an incandescent switch.

It is always preferable to have contact surface on both sides of the lever carrying the current, *i.e.*, double contact springs; as, in this way, a better and more trustworthy contact is obtained. The contact springs must not be of too thin material; preferably they ought to be made of two or three thicknesses of spring copper, which are riveted to the binding post to which the conductor is secured. The very best way of securing the contact springs is to set them in grooves milled out for the purpose in the base of the binding posts and then rivet them. The contact spring ought to be split or cut up to almost its entire active length in two to four parts, depending upon the size of switch, because this makes it more flexible; and if there is an uneven spot on the contact surface of the lever, it will adjust itself to the unevenness and still make a good contact.

The contact springs or the lever must be so shaped that the lever leaves the contacts along their entire length at the same time. If it does not, the spark, in throwing the switch open, will concentrate itself at the point of last contact, and, in case of a heavy current, burn or fuse it.

The cross section of those parts of the switch that have to carry the current must have a conductivity according to the current to be carried, corresponding to 800 to 1,000 ampères per square inch.

The action of the switch must never depend upon springs, spiral or flat, through which the current passes, as the current will invariably more or less heat and take the springiness out of them, thereby causing the switch to give out.

Never let the pivot-bearing of the lever form one terminal of the switch, as the current in passing through the bearing will heat it, no matter how carefully it is made, and sooner or later put the switch out of order. Each terminal ought to have contact springs for itself. This might make the bridge cost a trifle more, but it is a far better construction. The general practice to-day among leading manufacturers is to make such independent contacts for each terminal.

The set screws for holding the conductors in the binding posts ought to be large enough to stand a good tightening. Preferably they ought to be of iron, with square heads, so as to be tightened with wrench wherever the size of the switch allows it. The number of threads in the binding-post into which the screw engages must be large enough, so that there will be no danger of stripping the threads in tightening the screw.

In the case of a switch operated altogether by hand, without assisting springs, the lever ought to be provided with a stop device, which keeps the switch open, preventing it from accidentally closing the circuit. This is especially important in alternating current switches on the primary circuit, where an accidental closing of the circuit can endanger lives.

The handle is, of course, always made of wood or other insulating material.

The base of the switch ought to be made of fire proof, insulating material, for which slate, porcelain, hard rubber, moulded mica, &c., are suitable, and is now extensively used. If the base is made of wood, the front side ought to be covered with mica, so as to prevent the spark, that possibly can be formed, from setting the base on fire.

The cover in switches for low tension currents is generally made of metal, but it must always be insulated from those parts of the switch that carry the current. On the inside of the cover is generally placed one thickness of thin vulcanised fibre.

The practice so far has been to make all station switches, whether for high or low tension, open, *i.e.*, without cover; but the probability is that before long they will be provided with an insulating covering, at least where high tension alternating currents are used, so as to prevent accidents to the attendants.

The use of single pole switches is comparatively rare, especially in distribution of electrical energy at constant potential; switches are generally made with double poles, which in every case are to be preferred as by them a certain part of a circuit or a certain machine in a system can be completely disconnected by one movement of the switch lever. This is absolutely necessary where high tension alternating currents are used, and is compulsory wherever rules of a Board of Electrical Control or a Board of Fire Underwriters are adopted.

In order to prevent the possibility of the lever stopping at an intermediate point, whereby only a part of the contact surface would have to carry the whole current, resulting undoubtedly in destroying the switch, and further to prevent forming a spark at the instant of breaking the circuit, so-called snap switches have been invented. They are so constructed that the switch lever, once started by the operator turning the handle, is brought to its furthest position by means of one or two springs, independently of the movement of the handle. These springs are carried over the centre by turning the handle to a certain point, but act from that point independently of the handle. Thus all danger of the switch stopping on an intermediate position is prevented, as is also the forming of any destructive arc in opening the circuit.

For these reasons all switches outside of central stations ought to be made "snapping," *i.e.*, to quickly close and open the circuit independently of the speed with which the operator turns the handle. There are several meritorious designs on this principle in the market.

Constant current switches are made on a somewhat different principle from constant potential switches, as in this case the circuit must never be opened. The duty of a constant current switch is to cut out a certain loop or part of the circuit; but as the loop carries the whole current, it would interrupt the service on the whole line to open the circuit in the loop. The switch

* *Electrical World.*

must therefore short circuit the loop before it disconnects it. Even these switches are made "snapping," although there is no absolute necessity for it if the short circuiting is properly done before the cutting out.

As a conclusion, I will say a few words about the latest developments in switches, which I have been recently engaged in designing, and in which the most important conditions for a first-class switch are fulfilled. These switches are to be used on the alternating circuits in connection with the underground cables in the New York subways to disconnect converters from the main circuit.

The requirements to be fulfilled by these switches are that they shall be water, moisture, and fire proof, and have an insulation resistance at least equal to that of the underground cables; in addition to which they must be so arranged that moisture cannot enter the insulation of the exposed ends of the cables terminating in the binding posts. The cables from the subway enter a cast iron box at one end, passing through a special kind of clamp screwed into projections on the outside of the box. These projections are made hollow to receive insulating cups, through which the cables pass to the binding posts. The cups are filled with insulating compound after the cables are in place, which then surrounds the bare ends of the wire, preventing moisture from entering the insulation. The cables leading to the converters pass through pieces of gas pipe screwed into corresponding holes on the opposite side of the box, and are soldered to them.

The switch is a double pole quick break switch, which is mounted on a hard rubber base. The switch stem projects outside the box through a stuffing-box in the lid, and can be operated from the outside by a handle, or the lid is screwed on and made water-tight by means of soft rubber and cement.

ELECTRIC CAR TRUCKS.

By FRANK B. LEA.

IN a recent article (see the ELECTRICAL REVIEW of 27th June last, page 722) the writer endeavoured to show the possible course that will be followed in the development of electric traction so far as regards the type of car employed: and it was then seen that—apart from questions concerning the traffic—the most favourable ratio between paying load and dead weight of the car is obtained by using vehicles of large size.

That is, if the traffic may be fairly met by running large cars with heavy loads, the dead weight to be moved (and therefore the waste power exerted) is much less in proportion to what it would be with smaller vehicles designed to carry, perhaps, half the number of passengers.

It is assumed, therefore, that the electric tramcar should—for these reasons alone, and apart from other considerations—be made as large as possible. Of course there must be many instances of lines where a frequent and light service becomes necessary; but cases are perhaps equally numerous in which the traffic throughout a greater part of the day is met by running large cars at considerable intervals, any additional rush of traffic being accommodated by extra cars in the morning and evening.

There are, however, serious restrictions to the size of cars built upon the ordinary plan, not by any means the least of these being the unpleasant see-saw rocking motion ("teetering," as it is called in the United States) which appears to be an inevitable accompaniment of a long car having seats on the roof and provided with the ordinary central under-frame on four wheels.

Then, again, the rigid connection of wheels and axles in such a system places a low limit on the ability of the car to run smoothly and safely round sharp curves, such as are frequent on street railways.

A much pleasanter motion as well as extreme ease in traversing curves is obtained by the use of small four-wheeled bogie trucks placed one at each end under the car frame, which pivots on them, and slews round on the pivots in traversing curves.

Advantages like these will probably more than compensate for the extra cost incurred, especially in view of the saving effected in the power required for traction.

There is at any rate no harm in assuming that many electric cars will and must be built on such a plan; engineers, indeed, are not wanting who predict for high speed railway work the almost exclusive employment of bogie cars with motors mounted on the trucks, as opposed to the use of independent locomotives.

On the point of tractive effort alone, it stands to reason that greater efficiency should be obtained where every wheel is a driver.

The Reckenzaun accumulator car of 1884 showed in this respect really more advance than others of a recent date, and as a type of vehicle, was well worthy of greater success than it appeared to obtain.

It is, however, useless to say that bogie trucks may be advantageously employed for electric tramcars without looking into the question as to whether such an arrangement is immediately feasible.

The average bogie truck is very like the proverbial chamber where it proved somewhat difficult to swing a cat round in safety; and just as there is a maximum space available for the motor, so also the latter has a minimum size for a given output.

The best proportions of both truck and motor details may be obtained from an examination of standard types. Thus, the ordinary bogie wheel measures, perhaps, 32 inches in diameter. At a normal speed of seven miles per hour, this implies, say, 80 revolutions per minute.

Assuming, for the moment, that there is only room for a single set of gear for reducing the motor speed, this reduction cannot well be less than in the proportion of 1 to 5. With a spur pinion on the motor spindle of 3·7 inches diameter, this should give a large gear wheel on the truck axle of, say, 18·5 inches diam. and a motor speed of 400 revolutions per minute.

An Immisch motor of the S.M. 8 type will give a maximum of 8 brake horse-power at this speed; and its over all dimensions are approximately 4 feet in length, 14 inches in depth and 22 inches in width.

Of course the ultimate decision as to what motors shall be employed must depend upon the condition of the line, gradients, &c., but in most cases it will be found amply sufficient to use, say, one motor (such as that above mentioned) on each bogie truck.

On level parts of the line a single motor would serve to work the car, the other meantime running idle; but both could be used in going up-hill with a heavy load.

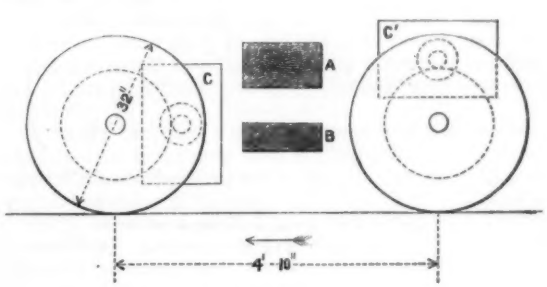


FIG. 1.

This plan allows of the driving truck being, as a rule, in the rear of the car, so that in case the forward wheels should miss the points at a junction and mount the rails, there would be less difficulty in drawing the car back.

Assuming, then, that these various advantages permit of or render advisable two end trucks for the car, and a motor upon each, it is not a very difficult matter to arrive at the amount of space available for motor and gear; and the annexed outline sketch will show what is possible with ordinary designs.

The wheels are of the common size adopted for trucks, viz., 32 inches diameter; and the wheel base is 4 feet 10 inches. At A is represented the spring plank upon which is fixed the pivot plate for the car frame to bear on; this plank goes right across the truck and is therefore shown in section, perhaps rather larger than is usual, but erring on the safe side for strength.

B is the bolster plank, to which are fastened the slide columns; between A and B are placed the powerful springs that give its characteristic easy motion to a bogie car. The plank B also traverses the truck, and therefore the motor and gear must be fixed on either side, not centrally.

C, C′, represent the motor (seen endways) in two different hypothetical positions; in either case, of course, it would be supported in the well-known fashion, due originally, it is said, to Mr. F. J. Sprague, that is, with curved extensions from the pole pieces to the truck axle and bolster plank.

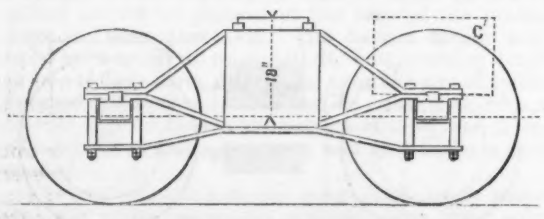
From the former the motor hangs by means of two ordinary bearings, whilst to the latter it is fixed with a double spring connection (tension and compression), so that, whether running backwards or forwards, there is a slight amount of play in the gear, which serves very materially to reduce strains.

It will be noticed that no details whatever of the brake gear have been shown; although these are, of course, very important and essential, they may yet be put aside for the time being until the motor question is decided. When that is done, there will be ample space and opportunity to bring in suitable appliances for braking the car, even if great modification of present designs should be necessary.

In the vertical position of the motor (shown on the left of the sketch) there is plenty of room above, between the motor and car floor, but very little underneath. The bottom of the motor reaches to within six inches of the rail level. In its horizontal position, the top of the motor would in all probability come too near the car floor and frame, unless the design allowed sufficient space for the motor between two adjacent floor stringers (running lengthways of the car), so that the framework might swivel when rounding curves.

Of the two positions, however, the horizontal one seems preferable owing to the greater ease of access; and it is a simple matter to raise the spring plank and pivot plate for the car frame so that the latter may clear the motor.

This implies a little difference in form of the standard diamond truck frame—as shown in the annexed sketch—but the change is merely one of form,



Sketch showing outside frame of bogie truck, with spring plank slightly raised so as to allow the car framework to clear the motor.

FIG. 2.

and does not add in any way to the cost.

By this means a clear space of 18 inches is obtained between the wheel centres and top of spring plank in its normal position; and this space should be sufficient to allow of the motor being fixed in position, as shown at C′, above the axle.

As regards the length of motor, a space of 4 feet will more than house it comfortably; and on the usual rail track of 4 feet 8½ inches, there should be no difficulty in securing enough room between the wheels.

In tracing out conclusions from the details thus given, it may fairly be said—

1. That a minimum size has been allowed for the motor.

2. That, consequently, any material increase in the size of car, average load, &c., necessitating the use of a larger motor, will also offer considerable difficulties with respect to the fitting of such a motor upon the standard bogie truck.

3. That only one set of gear has been allowed for; and if a double reduction is desired, the whole design will need considerably modifying.

4. That although it seems a very convenient and simple device to use two motors on each car, there are many drawbacks to such a plan; not only is the first cost greater, but the working expenses also are heavier. Multiplication of machinery is always undesirable. This question, however, deserves separate consideration; there are *pros* and *cons* of importance to be looked into.

5. That it is quite possible to adapt the ordinary four-wheeled bogie truck for use with an electric tramcar, but the task presents considerable difficulties that need the exercise of great care, and it is not so easy as might perhaps at first appear.

SHALL GAS UNDERTAKINGS SUPPLY ELECTRICITY? YES.*

By ARTHUR F. GUY, Assoc. M.I.E.E.

THE natural inferences that would be drawn from the above title by gas managers would bear upon the all-important points:—First, what are the objects of so doing? Second, what profits would accrue therefrom?

The first is a question of policy, the second a question of £ s. d. This paper is an attempt to place fairly and concisely before owners of gas property the salient points in each case for their consideration as to the advisability and practicability of gas companies supplying electricity; the tone of the paper, as the title implies, is affirmative.

There are, perhaps, no more powerful organisations in the country than those of gas undertakings, and this is not to be wondered at. Throughout the length and breadth of the land they exist, from the largest cities to the smallest towns. The amount of capital invested in them is enormous. They yield good, and in some cases splendid dividends, and, in short, they are generally in a thriving and prosperous condition. The men who conduct them and have a voice in their proceedings are mostly those of influence and position in the district concerned, and the result is these properties form no small item in a nation's prosperity. The key to all this prosperity is, that they, up to the present time, have had no rival, gas being in universal use.

The general feeling prevalent among gas managers is that the electric light cannot affect gas, and in proof of this they point out the fact that since the electric light has been introduced the consumption of gas has increased. This statement is perfectly true, because artificial illumination is ever on the increase, whether it be by gas, candles, or electricity. Another argument put forward by them is that the electric light is in its infancy. Now this argument must be combated, because the term infancy is applied not only to usage but to the science of electrical engineering. The first point, namely, the "infancy of usage," is, perhaps, correct; but the second is not. We will consider the former first. There are some people who fondly dream that in this miraculous age of invention and discovery some means will come to light whereby any amount of electricity can be collected for next to nothing—in fact, a gift from Dame Nature, such as from some yet undiscovered chemical compound, or some peculiar condition of matter—and consequently that all our present costly and elaborate apparatus for generating elec-

* Abstract of paper read before the Gas Institute.

tricity will become obsolete. No greater philosopher's stone was ever imagined.

With respect to the electric light being in its infancy as regards use, it is this fact that has shaped the title of the paper, for now is the time for the gas undertakings to act; it will soon be too late, and even now they have lost many a rich prize in the electric lighting line. Companies have been formed all over England to supply electricity, and the pick of the provisional orders have been relegated to either local authorities or private electric companies. This point joins issue with the supreme question, "Shall gas undertakings supply electricity? Yes;" and the reasons that justify this answer will now be given.

Consider the present state of affairs: there is a demand for the electric light; this demand is limited, but in time to come—and no one can say how soon that may be—this demand will be enormous. There are numerous reasons why it would be both politic and advantageous for gas undertakings to supply electricity.

The managing body of a gas works consists of men of great organising and administrative experience. The gas works from long establishment have obtained a certain prestige and influence in the district they supply. A manager knows his customers, and has acquired an insight into the weak and strong points of his district. The connection and vested interests pertaining to the gas suppliers are often numerous and deep-rooted. A gas undertaking has also the great advantage of easily raising capital, at a comparative low rate of interest; whereas new electric companies require financing, and the financing invariably leaves its mark upon them in the shape of a diminished dividend and an abnormally large capital. Many gas companies have large surplus monies in hand which could be invested in running the electric light at a profit to their shareholders. In the laying of electric mains they know exactly the position of their gas pipes, and so there would be none of that friction and petty annoyance that often arise when the electric light company comes on the scene. With regard to the erection of plant, where possible the electric light station should be located in or about the gas works. In some cases, no doubt, there might be a spare corner or outbuilding which might be made to accommodate the requisite machinery. At all events, the expenses incurred need not be so great as where a new site has to be acquired and a new building is specially erected and positioned by an electric light company. A large staff of men are employed at some gas works, some of whom are mechanics, and the assistance which these could render, both in erecting plant and maintaining same, would be of no small value. In the case of an electric light company, such men would have to be especially engaged, and paid at fixed salaries, whether busy or slack. Besides this, most of the office routine might be done by the existing clerical staff of the gas company. This, again, in the case of an electric light company, would mean specially engaged and paid clerks. An electric light company would require a board of directors, general manager, secretary, &c., all of which means a heavy draw upon the dividends, and this matter alone is sufficiently important to turn what might prove a good dividend into a bad one, or even none at all. In the matter of running expenses, there are numerous ways and means whereby a gas manager has the power of curtailing them. For example, the hot coke from the retorts can be utilised in starting the boilers, and some of the bye-products might be used as fuel.

Through being a large consumer of coal for making gas, steam coal ought to be obtained at much cheaper rates. The same refers to the purchasing of other material. The manager knows the best market for certain goods, and through long connection therewith ought to obtain advantageous bargains. The opponents of this paper will probably contend that if a gas works offer all these advantages it proves that it is badly managed, since, if well managed, there should be the strictest economy in everything, and not a man employed except his time be occupied fully, and not a spare inch of ground in the works but that it has its use. This would be true if the management were perfect, but that point is never reached. No claim has been made that these advantages exist to a large extent, for that would certainly imply waste in the management; but that *some* advantage must be gained from each of these points under consideration cannot be denied.

It is the numerous small savings that in the total make up a respectable sum; however trifling each may appear by itself, when they are all added up at the end of a year it is just possible that they may come to a sum that will turn the balance to the right side of the ledger. It was stated that owners of gas property have great facility of raising capital. Now, with regard to this point, and also the opening up of streets for the purpose of laying electric mains, it is requisite that they obtain the necessary powers first from Parliament and the Board of Trade, and in the furtherance of this they occupy exactly the same position as any private individual or other company (for the second object they must first obtain consent from the local authorities). The same holds true where the owners of gas works are the local authorities.

If the gas companies are desirous of supplying electricity, those who choose should combine to obtain Parliamentary powers authorising them to raise capital and open streets for the supply of electricity, each company, of course, first obtaining the necessary consent of the local authorities.

The number of provisional orders that have been granted since the passing of the Amended Electric Lighting Acts in 1888 has been very great. The majority of these are possessed by private electric companies and the rest by local authorities; as for the owners of gas undertakings, there probably is not one which possesses an order, excepting Bradford Corporation.

Attention may be directed to America, where there are quite 100 gas companies supplying electricity in connection with the Thomson-Houston system alone. How many are supplying electricity by other systems is not known exactly, but they must come to a large number. And to show that electric light industries pay, it may be stated that the Thomson-Houston Company has invested in them £10,000,000 sterling, and each plant on an average throughout may be taken to be worth £20,000. Some pay 18 to 20 per cent., others less, and on the whole the average is 4 per cent. on the total capital; but it must be remembered that 25 per cent. of these stations are in their first year, and therefore as yet they have paid no dividend, because they are just starting. Taunton Electric Light Company paid 5 per cent. first year, 6 per cent. second year, 5 per cent. third year.

If a gas undertaking wishes to take up the supply of electricity, what they should do in the first place is to obtain the services of a competent electrical engineer, and let him advise them as to the cost and system to be employed.

If things continue like this, where will the gas company be in a few years' time? They will have in every district where there are gas works an electric light company competing with them, and then they will see that it would have been well if they had obtained a footing themselves. Assuming gas companies supply electricity, and looking into the far future, who knows but that gas works will eventually become electric light works, and that as the electric light enters into universal use, so will gas die out?

A comparison of cost between gas and electricity will now be made. The ordinary gas jet in private houses may be taken to give about 14 actual candle-power, burning 5 c. ft. of gas per hour. Let the price of gas be, say, 3s. per 1,000 c. ft. The cost of 5 c. ft. would be ·18 of a penny for 14 candle-power, and for 1 candle-power the cost would be ·013 of a penny per hour. Now, take the case of electricity. Assume that the price is 7½d. per unit. A unit signifies 1,000 watt-hours. An incandescent lamp of 16 actual candle-power absorb 56 watts; that is, 3·5 watts per candle-

power; and the cost of this is 1-40th or ·025th of a penny for 1 candle-power per hour.

This is for the supply of electricity alone. The cost of the lamp must now be considered. The lamp may be taken to last 1,000 hours, and costs 3s. 9d. Therefore the cost of 1 candle-power per hour will be ·0028 of a penny;

Hence total cost is... ... ·0250
·0028

·0278 of a penny.

Therefore, gas costs ·013 of a penny per candle-power per hour; electricity, ·0278 of a penny per candle-power per hour. So that with gas at 3s. per 1,000 c. ft. and electricity at 7½d. per unit, the cost of the latter is little more than double that of gas, or, say, 6s. 2d. for an equivalent amount of light.

The following table gives the equivalent cost of gas for different prices of electricity per unit :—

Pence.

Per unit of electricity ...	4	4½	5	5½	6	6½	7	7½
Per 1,000 cubic feet of gas	41	46	51	56	61	66	71	76

Pence.

Per unit of electricity	8	8½	9	9½	10	10½	11	11½	12
Per 1,000 c. ft. of gas	81	86	91	96	101	104	110	115	120

The above is for incandescent lamps, not arcs. From the above table it will be seen that the approximately equivalent cost of gas is obtained by multiplying the price per unit by 10. Also, that every rise of ½d. per unit of electricity means a rise of 5d. per 1,000 c. ft. of gas. The price adopted in London is 7½d. per unit, or equivalent to 6s. per 1,000 c. ft. of gas. Gas works which supply electricity ought to be able to do it at 6d. per unit, and there are numerous towns in England where 5s. per 1,000 prevails for gas. This is bringing the price down in these cases on a par with gas. The gas committee of the Bradford Corporation supply at 5d. per unit, equivalent to 4s. 3d. for gas, and have a separate station for electric lighting. Local authorities, whether they possess gasworks or not, ought to be able to supply at this rate, so that when it comes to be a question of general adoption, and local boards throughout the country begin to establish central stations, there is this fact prominently before gas people, that the electric light can be supplied at equivalent cost of 4s. 3d. for gas. This is a price not out of the way, and certainly cannot be called expensive or high; and numbers will be glad to have it at this price for the sake of its superior illuminating power. Where great intensity of light is required, arc lamps afford a very cheap illumination; and for equal light with gas, its equivalent cost for gas would be only about 1s. 8d. per 1,000, or, roughly, the arc lamp costs only about half that of gas for the same amount of light—taking gas at 3s. per 1,000 c. feet., and electricity at 7½d. per unit. The reason of this is that for the same amount of electric energy the intensity of light emitted from an arc is about four or five times that from an incandescent lamp.

Before closing this paper, a few items will be given concerning the cost of installing plant. Take the case of a plant for 2,000 incandescent lamps, run by high tension alternating current dynamos and transformers, the wires being overhead, and supplying six miles of route. The total cost of putting down this plant, in the precincts of a gas works where a building could be appropriated, would be about £8,000 or £4 per lamp. It is found that on an average only two-thirds of the lamps installed in any premises are alight simultaneously; therefore, a capacity for 2,000 lamps means 3,000 installed in houses. To assume that each lamp installed is alight for 800 hours per annum is very moderate. This, then, equals the full load, or 2,000 lamps for 1,200 hours. 800 per hour signifies a lamp burning from dusk to a trifle after 8 p.m. every day throughout the year.

2,000 lamps for 1,200 hours consume
2,000 × 1,200 × 56
= 134,400,000 watts
= 134,400 units

and at 6d. per unit this equals £3,360.

The total working expenses, including 7 per cent. for depreciation of plant, would not come to more than 4½d. per unit, or £2,520. With a revenue of £3,360, this signifies profit of £840, yielding a dividend of 10½ per cent.

That the above is practicable may be proved by stating that the Electric Company at Rochester supplies electricity at 6d. per unit, and can pay a dividend of 11 per cent.

FIRE IN AN ELECTRIC LIGHT STATION.

AT 9.15 o'clock p.m., on Wednesday, the 11th inst., the central electric lighting station of the Manhattan Electric Light Company, located at the corner of Eightieth Street and Avenue B, in New York, was struck by lightning and very heavily damaged by fire. The lightning did not strike one of the company's circuits and come into the building over the wires, says the *Electrical World*, for in that case the bolt would have gone to earth through the lightning arresters placed upon the lines, but it struck the roof of the building itself and originated the fire directly underneath the tower through which the wires enter, and at the top of the incandescent light switchboard, and from this point the flames spread rapidly throughout the building wherever there was any combustible material to be consumed.

The equipment of this station was of an excellent quality, the building itself being of brick, with fireproof floors and partition walls, although the tower furnished a passage-way for the flames from the first to the second story. Customers using about 20,000 incandescent lights were supplied from 18 Slattery alternating current dynamos, while the arc lights were run from 11 machines of the Brush and Thomson-Houston types. The two switchboards, one for the arc lighting circuits and the other for the incandescent lighting, although near together, were kept entirely separate. Between them was a new and nicely furnished gallery, which had just been fitted up for the regulating devices of the incandescent circuits. The floor above the dynamo room was occupied by the offices and store rooms of the company, while upon the floor beneath was the engine room. This contained four 750 horse-power compound condensing engines, and two 350 horse-power high-pressure condensing.

The damage done was confined to the dynamo room and the offices and store rooms, as the fire did not reach either the engine or boiler rooms. Out of about 30 machines only two or three of the arc dynamos, that were located furthest from the origin of the fire, escaped such serious injury as to make them unfit for use. The 18 Slattery dynamos sustained an average damage of perhaps $1,500 each, although it is difficult to tell just what the damage will be until the machines are put into the shop and overhauled. The arc light dynamos, being further from the burning switchboards, were not so seriously damaged, although they were considerably injured by water. The incandescent circuit switchboard, together with 280 switches, 64 ammeters and about 70 voltmeters, was entirely destroyed. Fifteen compensators, 18 rheostats, and many other accessories were rendered worthless. The arc light switchboard, with its bank of switches, was partially consumed, and will have to be rebuilt and refitted. Every belt in the station was so badly burned as to require an entirely new outfit. Of the four large 48-inch engine belts, only one remained that could be repaired so as to be fit for use. Considerable damage was sustained upon the

stock, and upon the books, prints and drawings kept in the office of the engineering department.

The work of reconstruction and recuperation was begun at once after the fire, and the manner in which this has been done, and the rapidity with which the plant has been again put into running order, reflects great credit upon the management of the station, and is an illustration of the marvellous capabilities of a well-planned system of electric lighting. The night after the fire about one-half of the arc lights and 12,000 incandescents were supplied with current as usual, while on the second night 17,000 incandescents were connected, and on the third night not far from 20,000 lights. The company was able to make this fine showing through the kind assistance of its very obliging business rivals. Many of its lighting circuits, of which it has nineteen in all, were connected to other stations in the city, and have since been supplied by current from these stations. Meanwhile the company has been putting its own plant in running order. Five new Slattery dynamos were received soon after the fire from Ft. Wayne, Ind., by express, and other machines were sent for and received from the Thomson-Houston factory at Lynn, Mass., while the electric lighting companies in New York have very kindly loaned such machines as could be spared from their own equipment. By these various means the company has been enabled to replace in less than a week at least two-thirds of its entire plant, although, of course, this hasty installation has necessitated much work of a merely temporary character. When it is considered that the entire plant, with the exception of the engines, boilers and shafting, was rendered useless until replaced by new machinery, it must be admitted that the results obtained in so short a time reflect great credit upon Mr. E. A. Leslie, the general manager of the company, to whose energetic action much of the wonderful recuperation of the damaged plant is due.

COST OF ACCUMULATOR TRACTION.

AT the annual meeting of the Tramways Institute of Great Britain and Ireland, to which we briefly referred last week, several papers were read and discussed. The reading of papers before the Institute was a welcome innovation, as none had been introduced at previous meetings. It is, however, only to three of these that we need refer. The first was descriptive of the Birmingham cable tramway, and the only interesting facts elicited were that the initial cost of a single line one mile long ranged from £10,000 to £15,000, a double line of the same length, £25,000; and that the cost of working per car mile was 8·51d. for a car carrying 70 passengers. As compared with horse traction, which averages 6¼d. per car mile throughout the United Kingdom for cars accommodating 52 passengers, the cost for cable haulage is slightly greater.

The other two papers treated of electric traction. One of these was a mere recapitulation of the different systems and numbers of electric tram and railways in operation in the United States, the information being mainly derived from monthly magazines. The other paper, by Mr. A. Dickenson, C.E., of Birmingham, referred principally to electric traction in Europe. The author referred to the Julien system of electric traction—whatever that may be—and gave a detailed description of the accumulator cars shortly to be introduced on the Bristol Road route of the Birmingham Central Tramways Company. Turning to the Barking electric tramcars worked by the (now) General Electric Power and Traction Company, Limited, at a contract price of 4½d. per car mile, he stated that if the whole of the tramways in the United Kingdom had been worked last year at that figure the result would have been a saving of £200,000! The speaker, in conclusion, asserted that the Barking line had resulted in a small profit to the contractors.

The discussion on the two traction papers was taken together. Mr. A. Willbond asked for the authority for the statement that the Barking cars were a commercial success. The reply from Mr. Dickenson was that he was authorised by letter from Mr. R. Macpherson, one of the directors of the contracting company, to state that such was the case. Mr. Willbond then said that he would produce Mr. Macpherson's own figures, which showed conclusively that the line was a failure from a commercial point of view. This brought forth more than one protest from Mr. Dickenson, but it having been put to the members of the institute, who evidently not only relished the idea of the statement being contradicted, but who also desired not to be gulled on the subject, the speaker was permitted to proceed. He stated that from the opening of the line on the 14th June to the end of December last year, the total mileage attained by the cars was 34,366 miles, and that the total amount of profit made during that period, according to balance sheets shown to him by Mr. Macpherson, did not exceed £70. This sum of about £70 was realised after paying drivers' wages, expenses at charging station, including coal, oil and water, but exclusive of the engineer's salary. It, however, excluded one of the most important points in electric traction, namely, the cost of accumulator renewals. According to the generally admitted cost of renewing the accumulator plates, that is, from 1d. to 1½d. per car mile, or an average of 1¼d., the cars must have been worked by the contractors at a loss. Taking the actual mileage of 34,366 miles and multiplying this by 1¼d., the cost for renewals alone, without allowing anything for the depreciation of motors, gearing and for station plant, amounted to £178 19s. 9d. This showed, continued the speaker, a loss for the first 6½ months' operations of £108 19s. 9d. Therefore, the cost per car mile was 5¼d. without considering the expenses previously mentioned.

Several other gentlemen took part in the discussion, which was of a lively character. Mr. Dickenson again protested that Mr. Macpherson had given him authority to make his statement regarding the Barking cars, but he appeared to be under the delusion that two individuals could not know anything about the same subject. The president, Mr. Carruthers-Wain, said, however, that Mr. Willbond's assertions as to the commercial failure might probably not apply to the half year just ended, and that *possibly* the statement of Mr. Dickenson did so apply.

Mr. Joseph Smith, the chairman of the Birmingham Central Tramways Company, and upon one of whose lines the previously mentioned accumulator cars will shortly commence service, laid great stress upon the cost of generating the current, and stated that time only would show the *actual cost* of accumulator traction per car mile. He hoped at next year's meeting of the Institute to be able to lay before the members data concerning the actual working cost of the self-contained cars, which were to do service on one of his company's lines. Mr. Smith's remarks were well received, and the consensus of opinion seemed to be that accumulator traction at present was not commercially successful.

To the above we may add that if the Barking line is a paying concern, why did not the contractors send a qualified representative with *bonâ fide* data showing that such was the case instead of authorising one gentleman to make the assertion—which he could not prove—that the running of the cars had resulted in a small profit. Again, in addition to the data furnished by Mr. Willbond, there must be considered the salaries of the secretary and clerk, office expenses, interest on capital outlay, &c. Moreover, as a fresh set of plates were supplied for the batteries during April—May, the cost of these would at their then market price amount to over £1,000. We have, therefore, no reason for thinking otherwise than that the Barking line so far is a failure from a commercial aspect.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 638.)

VIII.—ARMATURE REACTIONS—(*continued*).

IN section VI. we saw that the E.M.F. of any machine was expressed by the equation

$$E = \frac{N s W}{10^8},$$

where N is the number of lines of force passing into the armature core from each pole-piece; s the number of revolutions per second, and W the conductors on the exterior. This is true for multipolar machines if the armature is coupled up in as many parallels as there are poles, and the output, multiplying by C is, therefore:

$$E C = \frac{N s W C}{10^8}. \qquad (7)$$

In our last article we observed that it was more convenient to express the load on the armature by the *volume* of current it carries, this being the product of the conductors on the exterior, and the current in each. The volume is equal to $\frac{W C}{p}$; whence substituting for W C its value, we have, in terms of the volume V, the output:

$$E C = \frac{N s V p}{10^8}, \qquad (8)$$

p being, as before, the number of poles. We have now two expressions which we shall find most convenient to apply to the design of machines. We have first the volume, which is expressed in terms of the induction in the air gap and the gap dimensions, and, secondly, the output given in terms of the volume, number of poles, and other dimensions. Without fixing for the moment these latter, we may say that the considerations which determine the output, so far as the armature is concerned, are known, but before the magnetising force required to produce the requisite induction in the air gap can be ascertained, it is necessary for us to consider the component of the armature windings, weakening the field.

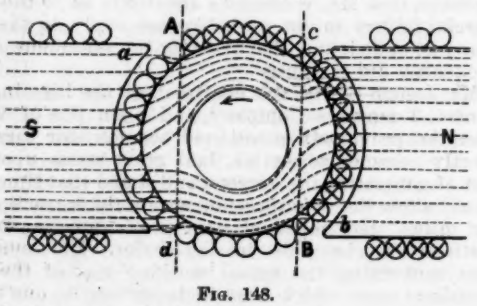


FIG. 148.

The brushes being placed at A and B, fig. 148, we have seen that the convolutions lying between the two vertical lines, A d and c B, directly oppose the forward induction, as they form a belt of conductors having a width equal to twice the angle of lead, in which the current flows in an opposite direction to the current round the magnets. If A_2 be the ampère turns on the armature, and λ the angle of lead, the ampère turns weakening the field are $\frac{4 \lambda A_2}{360}$, or calling W as before, the conductors counted all round the exterior, and C the total current, there are on the armature producing this effect $\frac{2 \lambda W}{360}$ turns of wire, carrying a current of $\frac{C}{2}$ ampères. This is the same as if there were wrapped round the armature, in a plane perpendicular to the direction of the field, $\frac{\lambda W}{360}$ turns of a conductor, having flowing in it, but in an opposite direction to the current in a field coils, C ampères, or the same current as carried by the armature. The demagnetising force in ampère turns is thus $\frac{\lambda W C}{360}$. In this expression the lead, λ, is assumed to be known, though, as already mentioned, its exact predetermination is a matter of some doubt.

In order to compensate the weakening of the field, the magnetising force on the magnets must be, according to this equation, increased by an amount equal to $\frac{\lambda W C}{360}$ ampère turns. We have had no opportunity of testing, experimentally, the accuracy of the expression, but so far as judgment can be given from what has been already done, this formula always gives a value for the ampère turns too low. It seems that the problem does not admit of such simplicity of treatment as here assumed, or probably other reactions are combined with the one in question, making it impossible to estimate accurately the effect produced by each. As regards drum armatures, Prof. Thompson remarks that a very convenient approximation to the back induction of the armature may be made by simply counting the number of armature conductors exposed between the horns of the polar surfaces, and multiplying this by half the armature current. He further explains that the nearness of this assumption arises from the fact that in most modern dynamos, for all currents, the point for the brush is at a position not far from that corresponding to the passage of t e commutated section from the idle space between the pole pieces into the working space in the polar gap. According to this statement, the angle between the pole tips is 2 λ, and the conductors between the tips are $\frac{2 \lambda W}{360}$ which, multiplied by the half current, gives $\frac{\lambda W C}{360}$, the expression before obtained. On the occasion on which Prof. Thompson made the above statement Dr. J. Hopkinson observed that, so far as he knew, the lead of the brushes in the best machines was never so large, and that the brushes were consequently behind the polar horns. The two statements appear difficult to reconcile, but if we take both as representing facts, omitting the explanation attempted by the former speaker, we come to this, that since the angle of lead is always less than half the angle between the tips, the formula gives too low a value, seeing that to obtain the actual ampère turns required for compensation we have to assume the lead to be greater than it really is. Doubtless, makers of dynamos have rules of their own for the compensating ampère turns to be added to the magnets; but very little in the way of experimental evidence on this point has been published, and the dearth of figures concerning a matter so important is much to be regretted. On the subject of drum armatures we have no evidence whatever, and very little regarding cylinders. Last February Prof. Ayrton made some tests on a Manchester dynamo, the results of which afford us a little information. This machine had 320 conductors on its armature, which carried a current of 31 ampères. The angle embraced by the pole pieces was presumably 140°, and we will assume that the lead was 20°, which would bring the brush just under the pole tip. Under these circumstances our formula would give for the magnetising force to compensate the back induction $\frac{20 \times 320 \times 31}{360} = 550$ ampères turns, whereas the value of the compensating ampère turns actually required was 1,200. In June, 1888, Mr. Esson made some experiments on a Phœnix dynamo, in which the weakening effect due to the armature was also observed. The armature of the machine tested carried a current of 92 ampères, and

had wound on it 180 conductors. The angle embraced by the pole piece was short, being only 112°. The lead of the brushes we will assume to have been 30°, though Mr. Esson thinks it was less than this; it was certainly not more. Under these circumstances the ampère turns required for compensation, as given by the formula, would be $\frac{30 \times 180 \times 92}{360} = 1{,}380$, but experiment showed that the extra magnetising force required was 2,610. The method of conducting these experiments is to run the machine at a constant speed, while having some arrangement by which the exciting current can be easily varied and accurately measured. The difference between the ampère turns required on the magnets when the machine is running without current in the armature, the brushes being on the no-lead line, and those required when the full current flows and the brushes are adjusted to their non-sparking point gives, the E.M.F. being in both cases the same, the magnetising force required for compensation. These are the only experiments of which we know referring to this question.

It is apparent, then, that a very considerable discrepancy has to be accounted for. Probably it is much less in drum than in cylinder machines, but for the latter it appears that there must be allowed about twice as many ampère turns for compensation as the formula indicates. This shows that the formula is not complete, that there are in fact factors omitted which considerably modify the results. In the absence of complete data the ampère turns necessary have to be determined experimentally by the makers for the different designs they manufacture. For the Phœnix machines the ampère turns which have to be added to the magnets to compensate the weakening are given by Mr. Esson as ·66 of the ampère turns on the armature. This is probably a fairly approximate coefficient for other Gramme wound machines

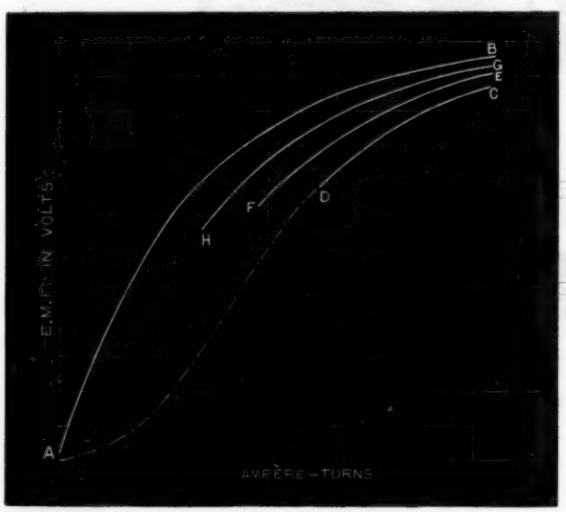


FIG. 149.

The weakening effect of the armature on the field may be conveniently recorded for any particular machine by a series of curves, as shown in fig. 149. The machine is run at a constant speed, and the field magnets separately excited to determine the relation between the magnetising force and the induced E.M.F. In the figure the former is represented by abscissæ and the latter by ordinates, the curve, A, B, being obtained while running without a current in the armature. The curve, C, D, is obtained when there flows in the armature the greatest permissible current, this being kept constant while the strength of the field is varied and the brushes adjusted to the sparkless position for each reading. The curve stops at D, because with a farther weakening of the field a non-sparking position cannot be obtained, and a less E.M.F. for that particular armature load and speed becomes impracticable. If, in spite of the sparking, the observations were continued with a gradually diminishing strength of field a continuation of the curve, as shown by the light dotted line, D, A, would be obtained. The curve, E, F, is obtained with a less armature load, and G, H with the load still further reduced. It will be observed that as the ampère turns on the armature get less the curve can be carried lower, or, in other words, the field can be weakened down to a greater extent before we arrive at the sparking point. From this diagram we learn everything which requires to be known respecting the magnetic circuit of the particular machine from which the results it represents are obtained. It tells us the ampère-turns required for any induction on open circuit, and how many ampère-turns must be added to compensate the armature reaction, or how many will be required to raise the E.M.F. by a required amount with any current flowing. That the ampère turns required to compensate the load are fairly constant for all values of the induction will be apparent.

In determining the magnetising force required for multipolar machines, we found it often advisable to ascertain the ampère-turns required for each individual field coil, considering the induction which had to be produced, and the lengths of the several components of that part of the magnetic circuit through which each coil had to force it. As in finding the magnetising force on the assumption of no armature reactions, this treatment was most convenient, so in dealing with the armature reactions it is found most convenient to determine the ampère-turns which are required for each pole to compensate the weakening effect, the ampère turns for each coil being then ascertained accordingly as the field is of the single or divided circuit class, and as there are one or two magnetising coils on each circuit. It will be remembered that in the divided class of field the induction from each pole takes a double path through parallels of magnetising coils, while in the single class, though the induction may take two paths, these are combined in one where the coils are, so that the whole of the lines from the pole pass through each coil. Whether the machine is bipolar or multipolar the compensating turns have to be determined experimentally—our object at the moment being to show that their value is determined by similar considerations and that the allowance for machines having four or more poles may be easily deduced from that provided for machines with two poles.

The ampère turns on the armature, by which each pole is directly influenced are found by dividing total volume of current the armature carries by the number of poles. As mentioned in our last article, we may imagine the conductors to be replaced by a cylinder of copper divided at the brushes into as many segments as there are poles, the sheet of current in each producing a direct effect upon its corresponding pole. The effect is seen first in the distortion or twisting of the field; secondly, in the weakening. On the assumption that the brushes are close to the tips, it will be remembered that all the conductors under the pole piece are concerned in producing the distortion, while those lying in the space between the tips of the adjacent poles produce the weakening. In the two pole machine we saw that the magnetising force producing the back induction was $\frac{\lambda \, W \, C}{360}$, or for each pole $\frac{\lambda}{360} \times \frac{W \, C}{p}$, where p is the number of poles. But in terms of our previous definition, $\frac{W \, C}{p} = V$, the volume which is carried by the armature, and we get, therefore, as a final result for the ampère turns demagnetising each pole, $\frac{\lambda \, V}{360}$, this expression being in terms of the volume, and like previous ones, independent of the number of poles.

It is probable that in multipolar machines the dis-

crepancy between the ampère turns which have to be added for each pole piece, and the number indicated by the formula is as great as in machines having two poles. Twice as many may be required in this case as in the other, and as already observed, farther information on the subject is much needed. Until this is forthcoming, however, it is sufficient to have shown that the same *kind* of expression is true for all types of machine.

(*To be continued.*)

EDINBURGH EXHIBITION.

EXHIBITS.

(*Continued from page* 722, *Vol. XXVI.*).

No. 59. *Messrs. Paterson and Cooper* exhibit a good assortment of dynamo machines, arc lamps, measuring instruments, and general electric light fittings. This firm's standard pattern of single magnet Phœnix dynamos is well known, and has been described in our columns on previous occasions. Different sizes are shown, suitable for belt or rope driving, and in addition is exhibited a Phœnix dynamo coupled direct to a "Westinghouse Special" engine, particularly suited for ship lighting or for employment where the saving of space is an object. This combination is shown in fig. 1, the cast iron bed plate which supports the engine taking the place of the usual machine bed, and forming, as does the latter, the yoke to the magnet. At a speed of 600 revolutions per minute the dynamo gives 45 ampères and 100 volts, furnishing power sufficient for 75 lamps of 16 C.P. each. The engine works at a steam pressure of 100—120 lbs. per square inch, and the speed is automatically governed. The cylinders are $4\frac{1}{2}$ inches in diameter, and the stroke 4 inches.

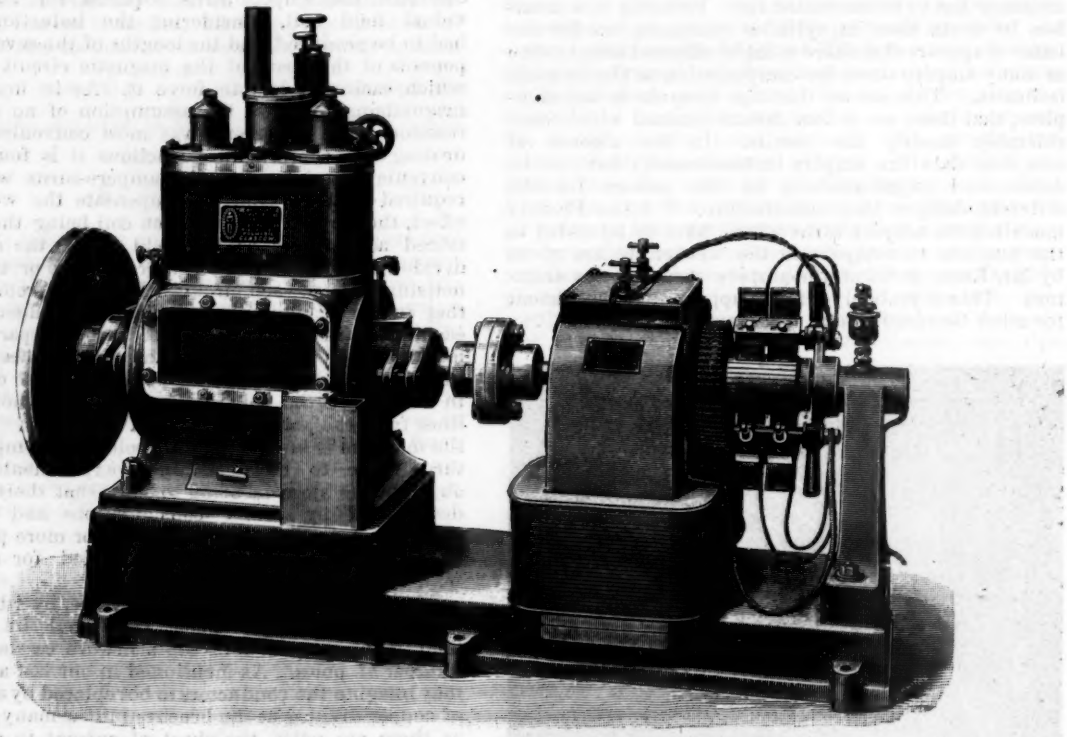


FIG. 1.—PHŒNIX DYNAMO AND WESTINGHOUSE SPECIAL ENGINE.

Amongst their electric lighting accessories are to be seen polished slate distribution tablets, for ship work, fitted with ammeter and voltmeter, fuses, and spring switches labelled with the names of the various circuits; also a large number of fittings specially designed for ship work. For saloons and cabins the lamp brackets and pendants are silver plated and of artistic design, while for deck and cargo work, fittings of a very strong design are employed suited to the rough work for which they are intended. The portable cargo lantern has a cluster of three 16-C.P. lamps, and is provided with a strong outer guard for protection; the hold lamp fitting is made of heavy iron, and has hinged to it a strong shutter, so that when closed up cargo can be placed in the hold against it without fear of its being damaged. In ordinary cases these lamps are only used in port when loading or discharging cargo, but should the hold be used for cattle or sheep they are very serviceable at sea. The regulation types of mast and side lamps fitted electrically are shown, each having two 16-C.P. lamps. It is claimed that the light is visible at a greater distance and clearer than that from oil lamps; also that in stormy weather they will burn perfectly steady when it would be difficult to keep oil lamps burning. Another appliance used in connection with ship work and shown at this stand is a small motor fan or saloon punkah. These have been applied to several of the eastern-going ships, fitted by Messrs. Paterson and Cooper, and the cool atmosphere provided by their use has added much to the comfort of the passengers. The fan attached to a small electromotor is placed near the end of the saloon, and furnishes a continuous supply of cool air, a switch for turning the driving current on or off being conveniently situated under the control of the steward.

Models of several of the steamers which Messrs. Paterson and Cooper have fitted with electric light are shown. Amongst these is the ss. *Parisian*, a handsome vessel, 440 feet in length, built for the Allan Line Mail Service by Napier and Sons, of Glasgow, in 1881. Her carrying capacity is 9,663 tons, and her engines are of 6,000 horse-power. She is fitted with 500 electric lamps, the current being supplied by two Phœnix dynamos, each belt driven from a separate high speed vertical engine. Another model shown is that of the ss. *Perth*, the fourth vessel fitted by Paterson and Cooper for the Dundee, Perth and London Shipping Company. This vessel has just been completed by the builders, Messrs. W. B. Thompson & Co., of Dundee,

and, in addition to the ordinary lights for the cabins and passenger service, special fixed lights are provided for the cargo work in the holds and on decks. In addition to the models several photographs of the steamers fitted by the firm are also on view.

The Phœnix arc lamp, manufactured by the firm, has a place at the stand, and is shown with its protecting cover removed in fig. 2. This lamp is of the differentially wound class, and is equally well adapted for burning in series on a constant current circuit or in parallel on a constant potential circuit. In the drawing, A represents an electro-magnet wound with coarse and fine wire coils, the pole pieces, P, acting upon an armature, K, fastened upon a frame, H, D, pivoted at F. The frame carries a brake wheel, B, on

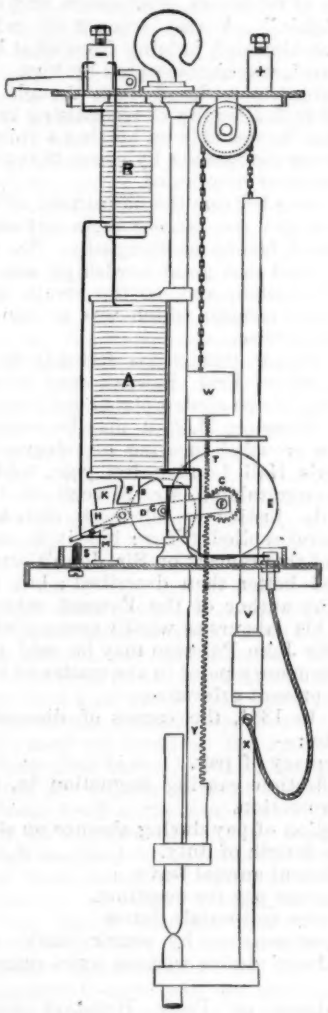


FIG. 2.—PHŒNIX ARC LAMP.

the axle of which is fastened a small pinion, G, and a brake lever, N, made to grip B by a helical spring attached to the frame. The pinion, G, gears into the larger toothed wheel, E, on the axis of which is a pinion, C, engaging with the rack, Y, of the positive carbon rod. This rod carries a weight, W, which in descending enables the negative rod, V, X, to be lifted. When no current is flowing the brake lever, N, rests on the screw, S, which releases the brake wheel and allows the carbons to come into contact. The action of the lamp is as follows:—The current enters the right hand positive terminal, passes through the framework of the lamp to the rod, Y, and thence to the positive carbon. It returns by the insulated rod, X, and flexible cord attached to it, passing through the coarse wire coils on A, and then to the negative terminal. The magnet attracts K, raising the frame, H, D, this causing the lever, N, to grip the brake wheel, and the toothed wheels, E and C, turning, the rod Y, is lifted, and X lowered, the arc being thus formed. As the carbons consume the difference of potentials at the lamp terminals rises, the current in the fine wire coils round A, which are a shunt to the terminals, consequently increasing. This weakens the electro-magnet, A, and allows the frame, H, D, to fall gradually, and the carbons to approach each other. When the lever, N, comes in contact with the screw, S, the brake is released, allowing the carbons to approach as the consumption continues. While the lamp is burning the end of the lever remains quite close to the screw. If the carbons burn out, or from any other cause the circuit through them is broken, the frame, H, D, drops on the insulated pillar, M; this completes the circuit from the lamp frame through the German silver resistance, R, to the negative terminal, thus preventing a break in the continuity of the circuit when the lamps are in series. When burning in parallel on a 65-volt circuit, the bye-pass resistance, R, is removed. The pole-pieces, P, and armature, K, are shaped so that for the same current and difference of potentials the pull on the frame is in every position similar, but should the current or difference of potentials alter, a small movement of the frame at once adjusts the arc to its normal length. A dash pot attached to the armature checks any sudden movement due to impurities in the carbons, &c. These lamps are installed at Peter Robinson's, Oxford Street, and Regent Street houses, at the Albert Institute, Dundee, and in many other important installations.

A variety of electrical measurement instruments, for which the firm has justly a reputation, is, of course, exhibited. Among these are the well known permanent magnet Ayrton and Perry instruments, which the firm has manufactured since their first appearance, and which still find a good sale. Several Phœnix deadbeat electro magnet ammeters and voltmeters are also shown, the controlling force in these being furnished by a strong spring instead of by the weak directional effort of an electro-magnet with a very small core. These instruments are made to measure currents up to 2,500 ampères. Cardew voltmeters of the latest pattern, as well as all forms of instruments used for electric light testing, are to be seen.

A model of a new system of railway carriage construction, designed by Mr. R. M. Short, is shown, the carriage containing first, second, and third class compartments, with lavatories, &c., electrically lighted. Though not in connection with electricity, Messrs. Paterson and Cooper have a model on view of Captain Anderson's patent hold-handy ladder, which is designed to supersede the dangerous hold ladder now in use. It affords easy access to the holds, and is of great convenience to shipowners and surveyors, when inspecting cargo, &c. The ladder is fitted on the ss. *City of Vienna*, and other steamers of the City Line.

OBITUARY.

JOHN BOURDEAUX.

IT is with great regret that we record the death of Mr. John Bourdeaux, submarine superintendent of the postal telegraphs on Her Majesty's telegraph cable ship, *The Lady Carmichael*, stationed at Dover. He died on Wednesday, the 2nd instant, at 8.0 a.m. Born in 1834 he had just completed his 56th year. Mr. Bourdeaux joined the Electric Telegraph Company when 15 years old, in the early days of telegraphy, and after two years' service with them joined the Submarine Telegraph Company. He went to Dover in 1862, and was submarine superintendent for the laying and repair of the English Channel and North Sea cables for nearly 30 years. Mr. Bourdeaux had a busy and anxious time in connection with the

transfer of the Submarine Company's business and plant to the Post Office. He had the double difficulty of looking after the interests of his old employers, and of making friends with the new ones; and, in assessing the value of cables, whose life and condition was extremely varied, much tact and diplomacy was required. During the tests taken immediately before the transfer Mr. Bourdeaux's health began to fail; and, though nominally in the Postal Service, he really performed but little duty since April, 1889. He was of a very genial disposition, with excellent conversational ability, and his general cheerfulness did so much to relieve the monotony of weather-bound cable operations that his absence will be exceptionally felt. He leaves a widow and 14 children.

ELECTRICAL SECTION, LONDON CHAMBER OF COMMERCE.

THE river excursion of this section of the London Chamber of Commerce took place last Saturday under somewhat unfavourable conditions. The night previous had been very stormy, and the wind and rain were still in evidence on the river, as in London, when the time for the start arrived. The applications for tickets originally numbered 55, but owing to some delay in settling the programme, &c., that number dwindled down to 44, and of these, only 22 put in an appearance at Windsor, from whence the electric launch was to take them to Henley. Some little surprise was felt when it was found that neither Mr. Trotter, who had been responsible for some of the arrangements, nor Mr. Kenric Murray, whose name had appeared to some of the notices issued, was present when the last trains arrived respectively from Paddington and Waterloo; but this surprise became as nothing when it was found that the General Electric Power and Traction Company's electric launch, the *Viscountess Bury*, which had been engaged for the occasion, was not forthcoming. Some petty excuse was suggested about a dynamo (presumably at the charging station) having broken down, but the *Ray Mead*, which had a party on board, seemed not to have been affected by the same disaster. Supposing, however, that the charging dynamo had broken down, there are more charging stations and electric launches on the river, and we cannot think why such an unfortunate *contretemps* was allowed to arise.

Well, the electric *Viscountess* not being available, a steam *Duchess* was engaged, which, by the way, could have accommodated conveniently no more than the small contingent which arrived, and the journey was made. The luncheon provided for 44 proved amply sufficient for 22; the weather cleared as the day advanced; and Major Flood Page, who kindly took charge in the absence of Mr. Trotter, with much geniality and tact managed to convert a threatened *fiasco* into a fairly enjoyable excursion. When the Section again attempts an electric launch excursion we would suggest hiring the *Volta*, whose owners have never yet found it necessary to disappoint those who engage her.

TELEGRAPH CLERKS AND THEIR GRIEVANCES.

THOUGH it may be urged, by those who regard them with perhaps unsympathetic feelings, that the present "agitations" amongst various sections of the working community are of "mushroom growth," still this cannot be said of the discontent and agitation existing in the Postal Telegraph service.

In Parliament, where the agitators have many friends, through the press, through the medium of public meetings, and by numerous petitions, the grievances peculiar to the telegraph clerks in the service of the Crown have been again and again brought before the notice of the public, and since 1880-1 from time to time, at varying intervals, their claims to a better status have been made with a persistence, and, it must be added, a forbearance, which have not been without their effect on public opinion; and as a series of recent incidents appear to have somewhat accentuated their case, some reference to it here may prove of interest to our readers.

As is well known, a measure of reform was brought out in 1881 by the late Prof. Fawcett, who was at that time Postmaster-General. The great political economist had gone exhaustively into the varied features of telegraph clerks' grievances. Deputations of representatives—metropolitan and provincial—were closely and critically examined by him in the presence of a number of surveyors, postmasters, and other "permanent officials." A vast amount of evidence was placed before him, and, judging from what Mr. Fawcett afterwards said, was also accepted by him.

It is interesting to know that, though blind, Mr. Fawcett had such a faculty of recognising individuality of sound, that he was able on hearing a voice a second time to address the speaker by name, though the name had been but once mentioned.

It is also recorded that the permanent officials mentioned above did not receive these deputations with much show of favour or sympathy. To return, Mr. Fawcett declared that great hardships and grievances undoubtedly existed, and, in the result, the Fawcett scheme was the panacea which was to banish the ills of the whole service.

It would appear that it has failed to do so, and the lamented death of Prof. Fawcett may have curtailed the extent and scope contemplated for it by its author.

Sir John Puleston, M.P., it may be remembered, in addressing a crowded meeting of telegraph clerks at the Forester's Hall, London, last year, told them that when he congratulated Mr. Fawcett in 1881 on his efforts to do justice to telegraph clerks, the Postmaster-General replied, "Yes; but it is not enough." The effect of this remark on Sir John's audience may be imagined better than described; but it tends to show that the author of the Fawcett scheme did not look upon his labours as wholly accomplished, and his remark to Sir John Puleston may be said to be a very strong confirmatory point in the matter of the genuineness of the present grievances.

Now, as in 1881, the causes of dissatisfaction are attributed to:—

1. Inadequacy of pay.
2. Classification causing stagnation in, and irregularity of, promotion.
3. Deduction of pay during absence on sick-leave.
4. Undue length of duty.
5. Insufficient annual leave.
6. Inadequate pay for overtime.
7. Vexations and unfair duties.
8. The performance by senior clerks of assistant superintendents' duties without extra remuneration or privileges.
9. Attendance on Bank Holidays without extra remuneration.
10. Lack of superior appointments.

Into each of these heads the telegraph clerks throughout the service have gone very fully in their petitions, and that they have made out a case may be inferred from the fact that the Postmaster-General, having received a report from a departmental committee, has made fresh recommendations to the Treasury, and their advent is awaited, we can fully believe, with feverish and pent-up anxiety. Unfortunately the Treasury enjoys, rightly or wrongly, the reputation of being a sort of monetary "Court of Chancery," whose deliberations are uncertain, occasionally arbitrary, and frequently protracted to an almost unbearable point.

Touching generally upon points into which we cannot enter in detail, some concessions have been made in the matter of sick pay, and if it is granted to a few there can be no good or just reason for withholding it from the remainder, irrespective of class.

We may say that the granting of Bank Holidays is not insisted on, and the telegraph clerks are not unreasonable in asking for overtime for such days.

Inadequacy of pay and classification, which latter gives rise to many anomalies in the matter of position, salary and service, are evidently the two standard grievances throughout the service. From what we have read, and from what we know of the service, it seems possible that the maxima which clerks might reasonably expect to reach will never be attained, and the question must surely present itself to the thinking mind whether it were not better to abolish the barriers at several stages, and allow a steady and gradual rise through the grades to a maximum, which, after all, even under the most favourable circumstances, would not be reached until after upwards of 25 years' service. It is no satisfaction to a man who has spent his years in faithful and meritorious service to be told, as has been done in our public departments, that "he is very unlucky," "he was just in an unfortunate position," or that he is "worthy of every encouragement," when none is forthcoming. The reward of faithful service lies chiefly in steady promotion, and before leaving the general question of pay, we may point out one very striking disparity which appears to be apparently unexplained. Take the case of senior clerks—previous to 1881, the difference between the maximum of a senior clerk in London and that of an assistant superintendent was £60. In 1881 the difference was increased to £80. In 1889 we find that the difference reaches no less a sum than £110. No sufficient reason is given for this remarkable expansion on the one hand, and the standstill on the other. Other cases could be shown, into other points want of space prevents us going. We know that the position of Mr. Raikes is one of difficulty and responsibility. He has expressed a becoming desire to be "just before he is generous." It may be that the events of the next week or so will prove that he can be both, and yet we do not know that the telegraph clerks are asking for more than simple justice. We venture to assert that the nation does not wish to see any of its public servants in positions in which they fail to receive adequate remuneration and consideration from the nation's purse.

Science, ever marching onward, leaves behind it new theories, new systems, and new labours. To electrical science this truism peculiarly applies, and it cannot be said that even now a telegraph clerk has nothing more to learn. The service, indeed, ever moves on with the sciences. We need not dwell on the specially-trained intellectual force that has to deal with current topics of all kinds, from the reports of great Parliamentary or scientific debates down to the humblest of telegraphic business. In all departments it may confidently be said that a high standard is maintained. It is but right to expect that those connected with the greatest telegraphic system in the world should be in positions more than one degree removed from the fringe of poverty; that they should feel that they are cared for by an appreciative administration, and it is to be hoped that the Postmaster-General will see that no unnecessary time is lost in readjusting the balance of justice.

In conclusion, we may say with Sir John Puleston that the claims put forward by these public servants are indeed moderate, and we hope that the tension at present existing may be carefully, manfully, and wisely controlled by the men, and that their conduct may be marked by extreme forbearance and a due consideration of the public service, as, we also trust, their claims will meet with a speedy, just, and liberal recognition at the hands of their professed friend the Postmaster-General.

The Use of the Sprague Motor.—On account of the efficient regulation of the Sprague electric motors many printing firms in the States have adopted it in preference to any other form of power. The Sprague Company has now about 20 motors in use in Boston for operating presses alone, while the total number in that city is about 200.

NOTES.

The Electric Light in Warfare.—Some important electric light experiments were carried out in connection with the mobilisation of the Needles sub-section of the fortress of Portsmouth. The various forts and batteries which guard the western entrance to the Solent were supplied with powerful search lights, which have been fully engaged at night for the purpose of discovering the movements of the *Rattlesnake*, *Hecla* and other of Her Majesty's ships which were manœuvring in the vicinity.

Proposed Electric Lighting at Exmouth.—The Devon Electric Light and Power Supply Company, Limited, will apply for a provisional order for the lighting of the Exmouth Local Board district.

Proposed Electric Lighting at Guildford.—The House to House Electricity Company, Limited, has given notice of intention to apply to the Board of Trade for a provisional order, authorising them to supply electricity for public and private purposes in Guildford.

Electric Lighting at Bromley.—Messrs. Laing, Wharton & Down have given notice to the Bromley Local Board that they intend applying for a provisional order for the lighting of the town by electricity.

Halifax and Bermudas Cable.—The final splice was made on Monday last, and the cable will shortly be opened for the transmission of messages.

Barnet Lighting.—At the close of the meeting of the Barnet Local Board last week, Mr. James handed in the following notice of motion: "That the clerk be instructed to give notice to Mr. Joel and 'The Electric Light Company,' that this board will oppose any application by both, or either of them, for any provisional order or license extending beyond the term of Mr. Joel's contract with the board."

The City Lighting.—Says the *City Press*:—"When will the City be lit by electricity? The Commissioners of Sewers seem to be in no particular hurry, nor do the contractors for the two districts already apportioned. The third district will probably be kept in darkness to see how the other two get on. One contractor neglects to provide the necessary guarantee, and the other is supposed to be promoting a company to carry out the work."

The International Exhibition of Mining and Metallurgy.—The above exhibition will be opened next Thursday at the Crystal Palace. Among the probable English exhibitors may be mentioned Messrs. Davey, Paxman & Co., Richard Hornsby and Sons, Limited, Hathorn, Davey & Co., the Delta Metal Company, Limited, Sphincter Grip and Armoured Hose Company, Limited, W. H. Wilcox & Co., the Sandycroft Foundry and Engine Works Company, Limited, T. B. Jordan and Son, the Britannia Company, of Colchester, &c. Electrical firms will be conspicuous by their absence, Messrs. Woodhouse and Rawson United, Limited, being, as yet, the only intending exhibitors. Many South African and foreign silver, lead, gold, and copper mining companies will make a display of their products.

Electric Stations and the Public Health.—The Sanitary Council, Paris (Seine Department), has been requested to report upon the advisability of including electric stations in the list of *établissements insalubres*, by reason of the noise, trepidations, and smoke caused by them, and which have been bitterly complained of. In the last three years about 30 important electric stations have been erected in central positions.

Execution of Kemmler.—The latest report states definitely that Kemmler is to be executed by electricity.

Small Capitals.—The *Financial Times*, noticing the small capital (£100) of the Weston-super-Mare Electricity Supply Company and the Bristol Company, asks if the registrations emanate from the local gas companies for the purpose of protecting their interests. Our contemporary may be reassured on the point, and we recommend a closer scrutiny of the names of the promoters.

Telephonic Communication Between Manchester and Dudley.—The National Telephone Company notifies that communication has been established between Manchester and Dudley, and will henceforth be available.

Cathcart and Peto.—We learn that this firm has acquired the business and works of the Vulcan Manufacturing Company, makers of electric bells, indicators, &c., Rocliffe Street, Islington. The business will be carried on at the same address and under the same title as hitherto.

The Elmore Wire Company.—We hear that this company has contracts to take the whole of its output of copper spirals for the year 1891 at very remunerative prices. Mr. Elmore's latest invention in connection with the manufacture of mandrils for his process, we are assured is now a practical success. This is of great importance to the company, inasmuch as it has experienced the greatest difficulty in obtaining suitable mandrils.

Electric Lighting at Thetford.—The committee of the Mechanics' Institute has decided to fix the electric light throughout the building.

F. H. Royce and Company.—A revised price list of dynamos, dated 1st July, is being issued by Messrs. F. H. Royce & Co., of Manchester.

Platinum.—The difficulties attendant on the electro-deposition of platinum are well known, and the paper by Mr. Wahl, which we publish on another page, will prove a valuable addition to the literature, none too extensive, which exists on the topic. It is to be hoped that the day is not far distant when the application of platinum to plating purposes will become an industry of great importance, and *apropos* of this it may not be generally known that the price of this metal is about three times as much as was the case not long ago. One company, however, which uses this indispensable article in the manufacture of incandescent lamps was fortunate enough, when the market price was low, to lay in a stock sufficient to last for the next four years; a capital instance of the far sightedness of its well-known secretary.

The Cost of Electric Traction.—The General Electric Power and Traction Company will probably think it advantageous to give a reply to the assertions made by Mr. Willbond, during the discussion on electric tramways at the annual meeting of the Tramways Institute of Great Britain. To convert an assumed profit of £70 into an alleged loss of over £100 requires explanation, and we trust that the company is in a position to offer a satisfactory answer to Mr. Willbond's statements.

Personal.—Mr. A. P. Trotter has been appointed editor of the *Electrician*. We congratulate the proprietors of this journal upon such an acquisition to their literary staff.

Birkenhead Electric Lighting Bill.—This Bill, in an amended form, passed the Committee of the House of Commons on the 3rd ult.

The Telephone in Italy.—The Minister of Posts and Telegraphs contemplates the establishment of a system of telephonic communication all over the peninsula.

Extension of the Telephone in Hampshire.—Southampton and Bournemouth were connected last week by telephone.

A Question of Wrongful Dismissal.—In the Birmingham County Court, on Tuesday, Messrs. Snell and Prideaa, electrical engineers, Holloway Head, sued Thomas Lynch Hemming, electrical engineer, 94, Nursery Terrace, Hunter's Road, Handsworth, for £50 damages, for breach of contract to serve them for three years from 25th June, 1888. The defendant set up a counter claim for £249 as damages for wrongful dismissal in having refused to allow him to fulfill his agreement, and for the detention of certain tools and utensils. The case was tried by a jury. The jury gave a verdict for the plaintiffs for £30, and for the defendant for 7s. 6d. on the counter-claim.

A New Insulator.—The *Bulletin International de l'Electricité* mentions a new type of Berthoud-Borel cable, which is said to possess the property of insulation in a great degree. A layer of celluloid is first placed over the conductor, which is then encased in tarred hemp, over which a coating of some complex material follows. This last is said to offer a high insulation. Our contemporary is disposed to make light of the invention, seeing that celluloid possesses a high coefficient of dilatation, so that any sudden variations of temperature might occasion the loosening and destruction of the insulator, and, also, the imflammable nature of this material would have to be taken into account.

Newspaper Enterprise.—In consequence of the failure of the gas supply, the *Yorkshire Post* of Tuesday last week was produced entirely by the aid of wax candles. The text was written, the type set, and the paper was stereotyped and machined by the light of wax candles alone. Thursday's issue was to a large extent produced under very different conditions. The electric light was the illuminant in use from between 10 and 11 o'clock on Wednesday night. Such a rapid change from the modest wax-light to the brilliancy of electricity requires explanation. Because of the difficulty experienced on Tuesday night it was resolved on Wednesday morning by the management to introduce the electric light into the offices. The order for the installation was only given to Mr. Wilson Hartnell, electrical engineer, Leeds, at 11 o'clock on Wednesday morning, and it was at work at a few minutes to 11 at night. The power for driving the dynamo was, of course, already on the premises, it being derived from the engines working the printing machines. But the main shaft had to be cut for the driving pulley and a special countershaft provided, from whence the dynamo is driven, the latter running at 1,000 revolutions per minute. The installation consists of 40 lamps of 50 candle-power, and 20 lamps of 16 candle-power each, placed in the composing room, with six lamps of 100 candle-power in the machine rooms.

Raw Hide Gear.—In America the use of raw hide for gearing has come largely into use. It is often necessary to employ gear wheels running at a high rate of speed, and the wear which takes place, together with the accompanying noise, makes their use objectionable. Many attempts have been made to overcome these defects, and the patented solid raw-hide gears made by the New Process Raw Hide Company, of Syracuse, N.Y., have met with remarkable success. In the manufacture of the raw-hide, great pressure is applied, and all superfluous matter eliminated, leaving the same extremely light, and making it the strongest material for its weight known. The blanks are first cut, then a number laid together, and the teeth afterwards shaped out. The wheels so made have come into extensive use on electric cars, where their silent and even operation has added much to the comfort afforded by these cars. These gears may be run together or against metal gears, and require no lubrication. They are not only remarkably durable in themselves, but it is claimed that the life of large iron gears is longer, used in connection with them, than when running with metal pinions.

The Western Gas Association of America.— The Western Gas Association held its 13th annual meeting at St. Louis on May 21-23. In the course of his address, Vice-President C. R. Faben, Jr., of Toledo, O., said :— The electric light as a competitor to gas, for purposes of light, presents a solid front. How very profitable to investors these electrical undertakings may be, I question. From statements recently made I find that out of about 100 electric lighting companies in Massachusetts, only 15 declared dividends in the past year. Of these 15 companies 10 declared dividends of from 1 to 6 per cent., and only 5 declared dividends above 6 per cent. Leaving out the Boston companies, which by reason of the extent and value of their territory enjoy a greater demand for their light than exists in smaller places, the average of dividends paid by the electric light companies in the State, who paid dividends at all, has been only 4·9 per cent. Another fact in this connection is that no fund has been created by these several electric light companies to compensate for wear and tear. No depreciation has been charged off. The usual and necessary repair is supposed to represent all of the depreciations, so that the dividends paid are virtually taken from the plant itself or its value. Electric light companies are opposed to having any depreciation charged off other than the cost of repairs and renewals actually made.

Wire Calculator.—One of the most important problems to be solved by the practical wire man is that of proportioning the size of the wire necessary to carry safely and economically the amount of current requisite of charts and tables have been prepared with a view of helping wire men in this difficulty, but these at the for a given number of incandescent lamps. With the object of meeting the demand for something which would present the advantage of enabling the wire man to obtain results with great rapidity and conveniently, E. S. Greeley & Co., of New York, have have just put on the market a little device, called by the inventors an automatic wire calculator. It consists of two discs of stiff card-board of unequal size, the smaller one being mounted in the centre of the larger, and made to revolve thereon. On the back of the larger cardboard are full directions for the use of this unique and useful tool. One is arranged for the calculation of wire for of 110 volts, and it is understood another is in preparation arranged for 55 volts.

The Alternating System in Russia.—It is said the alternating system will be adopted by the Russian Government for lighting the buildings of the Imperial Palace, Zarskoe-Selo.

Brighton Lighting. — The committee has recommended that contracts to the extent of £7,027 be entered into with Messrs. Sharp and Kent, £5,242 with the Electrical Construction Corporation, £1,140 with Messrs. Sharp and Kent, in conjunction with Messrs. Goolden & Co., and £9,737 with Callender's Company. The net outlay, exclusive of the cost of the station site, will be, assuming only two sets of accumulators to be used, £26,887 ; with two extra sets, £29,429.

The Electric Light in Lancashire and Yorkshire.— Bills to confirm provisional orders made by the Board of Trade empowering the laying down of mains for the supply of electricity in Burnley, Morecambe, Bacup, Blackburn, Accrington, Blackpool, Huddersfield, Bury, Fleetwood, Lancaster, Salford, Crompton, Oldham, and Barnsley, have been before a committee of the House of Commons and passed, there being no opposition. A clause was inserted for the protection of telegraphic and telephonic wires.

Electric Tramway in Bremen.—The first electric tramway in Europe on the Thomson-Houston system was opened in Bremen on the 22nd ult. Three cars are employed, and others will subsequently be added. Each car carries two 10-H.P. motors.

Journalists Exempt from Juries in New York.— We note the following in the last issue of our transatlantic namesake :—" At last the journalistic profession has received recognition at the hands of the New York law makers. Editors and reporters will hereafter be excused from jury duty, ranking alongside of lawyers, physicians, and clergymen." When will the same privilege be granted in all cases here ?

The Praise-All Policy.—In a recent number of the New York *Electrical Engineer* a description of a "Method of Telephonic Transmission," devised by a Mr. W. Vogel, is given ; this description states that the invention "embodies a new application of the line wire to effect an increase in the efficiency of transmission. This is accomplished by maintaining the iron or steel conductor in a magnetic state, by which the effect of the vibrating armature of the transmitting telephone is propagated magnetically as well as electrically." The idea, which is about on a par with the spiral wire craze of a few years ago, is, we regret to see, spoken of in a leading article in terms which are not condemnatory of the absurdity of the so-called invention, though it is not urged that it might be a success ; nevertheless, further trials of the apparatus in practical operation are suggested. We believe that under the able hands of the late editor, the whole matter would have been treated with the ridicule it deserves ; moreover, a timely word might have saved the poor deluded so-called inventor a further useless expenditure of money which perhaps he can ill afford.

News from Abroad.—We are seriously thinking of the advisability of sending a few sub-editors to distant parts of the world, so that they may rapidly pick up information as to what is being done in London in electrical matters. We have, though fairly prompt, never succeeded in finding the items of news as rapidly as continental and American journals, and have come to the conclusion that being on the spot is the very worst way in which to acquire knowledge. Now, we were quite unaware that the Southwark Underground Railway had been opened, but an American contemporary announces that "recently there has been opened under the Thames a new subway, consisting of two tunnels each about 11 feet in diameter, for the use of an electrical railway, and trains consisting of a locomotive and three carriages, having accommodations (*sic*) for 100 passengers, are now run at frequent intervals from King William Street in the City to the Elephant and Castle in Surrey, a distance of a mile and a-third, in about three and one-half-minutes."

NEW COMPANIES REGISTERED.

Wakefield City and District Omnibus Company, Limited.—Capital £6,000, in £1 shares. Objects : To carry on in Wakefield, or within a radius of 10 miles therefrom, the business of an omnibus and tramway company in all branches, and to work by means of horse, steam, electricity, or other mechanical power. Signatories (with 5 shares each) : *H. M. Carter, J. L. Chaplin, B. Woodcock, G. F. Roberts, *F. K. Perkin, *W. H. Kingswell, *T. P. Robinson, W. Watson, Hy. Bennington, E. Long, H. Rollinson, *H. Shaw, J. J. Hillbert, H. Smith, *J. Cardwell, J. H. Holdsworth, J. Scott, G. Webster, W. Moorhouse, *S. Stephenson, all of Wakefield and its vicinity. The subscribers denoted by an asterisk are first directors ; qualification, £20 in shares or stock ; maximum remuneration, £100 per annum. Registered office, Wood Street, Wakefield. Registered 3rd inst. by F. B. Moss, Outer Temple.

Sherrin Electric Power Generator Company, Limited.—Capital, £100,000 in £1 shares. Objects : To adopt an unregistered agreement between John Sherrin, John Vaughan Sherrin, and H. Ferdinand Woodgate, of one part, and G. M. Canham of the other part. To carry on business as electrical, mechanical, and chemical engi-

neers and manufacturers, and as an electric light company in all branches. To manufacture and deal in apparatus, materials, and things for the generation, distribution, supply, accumulation, and employment of electricity. Signatories (with 1 share each): G. M. Canham, Park Terrace, East Twickenham; W. J. Leslie Mumford, Applegarth Road, W; G. Jackson, 39, Aspland Grove, Hackney; S. H. Barnes, 84, Crofton Road, S.E.; R. B. Storey, 4, Vicarage Gardens, Forest Gate; D. R. Crane, 3, Erlam Road, South Bermondsey; E. Price, 2, Hanklin Road, Crouch End. The signatories and vendors are to appoint the first directors; qualification, 100 shares, and for subsequent directors 200 shares; remuneration, £2,000 per annum, divisible. Registered 4th inst. by Francis and Johnson, 5, Austin Friars.

Note.—The company referred to in our last issue as the Henley Electricity Supply Company, Limited, should read the Hanley Electricity Supply Company, Limited.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Fowler, Lancaster & Co., Limited.—The statutory return of this company, made up to the 28th ult., was filed on the 5th inst. The nominal capital is £22,000 in £10 shares. 392 shares are taken up; upon 342 of these the full amount has been called, and £5 per share upon the remaining 50 shares. The calls paid amount to £2,600, and unpaid to £1,070. Registered office, Albert Works, Graham Street, Birmingham.

Maquay Syndicate, Limited.—The statutory return of this company is made up to the 23rd May. The nominal capital is £12,000, in 120 shares of £100 each, but the only shares at present taken up are the seven subscribed for by the signatories to the memorandum and articles of association. Registered office, 1, Shorter's Court, Moorgate Street, E.C.

Liverpool Silver and Copper Company, Limited (electrical treatment of metals).—The statutory return of this company, made up to the 10th April, was filed on the 22nd May. The nominal capital is £50,000, in £10 shares; 2,500 shares are taken up, and £3 per share has been called thereupon. The calls paid amount to £7,500. Registered office, 5, Fenwich Street, Liverpool.

Poole and White, Limited (electricians).—The statutory return of this company, made up to the 27th ult., was filed on the 3rd inst. The nominal capital is £20,000, divided into 3,400 "A" shares of £5, and 600 "B" shares of £5 each; 970 "A" and 600 "B" shares are taken up, the latter being considered fully paid. Upon the "A" shares £2 10s. per share has been called, the calls paid amounting to £2,425.

CITY NOTES, REPORTS, MEETINGS, &c.

The India-Rubber and Gutta-Percha Company, Limited.

THE half-yearly general meeting of the company was held at Cannon Street Hotel on Thursday, the 10th inst., for the purpose of obtaining the shareholders' sanction to an interim dividend of 5 per cent., or 10s. per share (free of income tax), payable on and after the 11th inst.

The Chairman, Mr. S. W. Silver, in moving the resolution, said that a rough estimate of the amount of sales made in the past six months fully justified the payment, as the sales were in excess of those of any previous half-year, notwithstanding severe competition, and a considerable increase in the price of the raw material. The works were fairly well employed. These satisfactory results had only been attained by the closest attention and care.

Mr. Grey seconded the resolution and, referring to the recent strike at Silvertown, said that no loss had been occasioned by it, as the company had been able to execute its orders from its works in France. Had proper police measures been taken, the strike would have been prevented at the outset, instead of continuing for some twelve weeks. The loss to the workpeople had been about £20,000, which they would have received had they continued at work. He hoped they would consider well the result of the last lesson before they struck again.

The motion was carried unanimously, and with a vote of thanks to the Board, the meeting dispersed.

The South of England Telephone Company.

THE report of the directors for the year ending 30th April, 1890, to be presented at the seventh ordinary general meeting to be held at Winchester House, on Friday, 18th July, at 12 o'clock, states:—The expenditure on capital account for the past year amounts to £14,116 2s. 10d., bringing the total of that account to £78,418 2s. 0d. The revenue account shows a sum of £21,549 18s. 9d. for subscriptions and rentals, and a net credit balance of £6,148 5s. 4d., making, with the sum of £627 1s. 2d. brought forward from last year, an available balance of £6,775 6s. 6d. Of this amount the sum of £1,796 14s. 7d. has been absorbed by the payment of an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ending 30th October, 1889. In order to strengthen the position of the company, the directors have considered it advisable to carry £1,000 to the reserve fund; and they now recommend the payment of a final dividend at the rate of 6 per cent. on the preference shares (£2,096 6s. 2d.), for the half-year ending 30th April, 1890, and the payment of a dividend of ½ per cent. on the ordinary shares, free of income tax (£1,500), for the year, leaving a balance of £382 5s. 9d. to be carried forward.

The completed trunk lines are as follows:—Brighton—Shoreham; Brighton—Eastbourne; Brighton—Worthing; Shoreham—Worthing; Brighton—Hurst; Brighton—Newhaven; Brighton—Rottingdean; Brighton—Lewes; Lewes—Eastbourne; Canterbury—Ramsgate; Ramsgate—Margate; Ramsgate—Sandwich; Ramsgate—Deal; Canterbury—Faversham; Canterbury—Whitstable; Canterbury—Dover; Dover—Folkestone; Chatham—Maidstone; Norwich—Great Yarmouth; Northampton—Wellingboro'; Wellingboro'—Kettering; Kettering—Rushden; Tunbridge Wells—Tonbridge.

The trunk lines in process of construction are:—Canterbury—Ashford; Faversham—Sittingbourne.

At the 30th April this year, 2,265 exchange lines and 583 private lines were completed, and 91 exchange lines and 19 private lines were in course of construction.

Telephone exchanges are now open at the following places:—Brighton, Cambridge, Canterbury, Chatham, Deal, Dover, Eastbourne, Faversham, Folkestone, Great Yarmouth, Hastings and St. Leonards, Hurst, Hythe, Ipswich, Kettering, King's Lynn, Lewes, Maidstone, Margate, Newhaven, Northampton, Norwich, Oxford, Peterborough, Ramsgate, Reading, Rottingdean, Rushden, Sandgate, Sandwich, Shoreham, Tunbridge Wells, Watford, Wellingborough, Whitstable, Worthing. Mr. D. Owen Bateson retires from the board by rotation, and, being eligible, offers himself for re-election. The shareholders' auditor, Mr. J. Weise, retires, and is eligible for re-election.

The following is a comparative statement of exchange and private line business of the company:—

	Exchange.	Private.
April 30th, 1886	687	248
April 30th, 1887	1,130	348
April 30th, 1888	1,521	386
April 30th, 1889	1,972	500
April 30th, 1890	2,356	602

The India-Rubber Estates Company, Limited.—The prospectus states that this company has been formed with a capital of £225,000, in 225,000 shares of £1 each, for the immediate purpose of acquiring and working a concession from the Government of the Republic of Liberia for the sole right of collecting and exporting India-rubber and gutta-percha from the republic, for the European and American markets, and with the intention of acquiring and working other valuable concessions relating to India-rubber and gutta-percha from other foreign Governments in Africa, America, Madagascar, and other parts of the world.

The Eastern Telegraph Company, Limited.—The directors after placing about £120,000 to reserve fund, recommend a balance dividend of 2s. 6d. per share and a bonus of 3s. per share, making a total distribution of 6¼ per cent. for the year ended March 31st last.

The Allgemeine Electricitaats Gesellschaft of Berlin.—This company will increase its capital by 3,000,000 marks. The new shares will be offered at 55 per cent. premium.

The Telegraph Construction and Maintenance Company.—An interim distribution of 12s. per share is announced.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 4th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,451.

The Great Northern Telegraph Company, Limited. The receipts for the month of June amounted to £24,600; 1st January—31st June 1890, £130,400; corresponding months 1889, £122,400; do. 1888, £132,000.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 3.)	Closing Quotation. (July 10).	Business done during week ending July 10, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 —100 xd	97 —100 xd	98¼	98
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51		
2,725,420	Do. do. 6 p. c. Preferred	Stock	86 — 87	85½— 86¼	87	85
2,725,420	Do. do. Deferred	Stock	14½— 15	14 — 14⅛	14½	14⅛
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12 xd	11⅛— 12⅛xd	11⅞	11⅛
99,000	Do. do. 5 p. c. Bonds...	100	101 —103	102 —104		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1996	100	103 —107 xd	103 —107xd	103½	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ..	3	2½— 2⅝	1⅞— 2⅛		
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅞— 2	1⅝— 1⅞		
$7,216,000	Commercial Cable, Capital Stock	$100	... ...	103 —105	103⅛	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	⅛— ¼	⅛— ¼		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5⅛— 5⅜	5⅛— 5⅜		
16,000	Cuba Telegraph, Limited	10	12 — 12½	12¼— 12⅜	12⅜	12⅛
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3 — 4	3⅛— 3⅜		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10 5/16	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14½	13⅞— 14⅛	14⅛	14
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15⅛	...
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 —111	108 —111	109½	...
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	107⅛	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14½— 14⅝	14½— 14⅝	14 7/16	14 1/16
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	101 —103	101 —103		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106 xd	103 —106 xd	106	105
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106 xd	103 —106 xd		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 —103 xd	100 —103 xd	100⅜	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5⅛	4⅜— 5⅛		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5⅛— 6	5⅛— 6	5⅞	5⅛
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2 — 2½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited	10	9 — 9¼	9 — 9¼	9 3/16	9 1/16
180,042	Do. do. 6 p. c. Preference	10	15 — 15⅜	15⅛— 15⅜	15⅜	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	15¾— 16¼xd	15¾— 16¼xd	15⅞	15¾
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	100 —103 xd	100 —103 xd	101	100½
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	105 —108		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½— 12½	11½— 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	19 — 20	19 — 20	19⅜	19⅛
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110	108¾	108
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	4⅞— 5⅛	4½— 5	5⅛	5
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5⅛— 5⅜	5⅜— 5⅜	5 13/16	5⅜
49,825	Do. New Nos. 386,876 to 436,700	5	5⅜— 5⅜	5⅛— 5⅛	5⅛	...
15,000	Do. 6 p. c. Cum. 1st Preference	10	12¼— 13	12⅛— 13	12⅞	12¾
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10¼— 10⅜	10⅛— 10⅜	10⅜	10⅛
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜		
9,000	Reuter's, Limited	8	7¾— 8¼	7¾— 8¼		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ...	¼— ...	¼	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3⅛ only paid)	5	2¾— 3¼	2¾— 3¼		
3,381	Submarine Cables Trust	Cert.	112 —116	112 —116		
78,949	Swan United Electric Light, Limited ... (£3⅛ only paid)	5	5⅛— 5⅜	5 — 5⅛	5 3/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45⅛	44
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102 xd	100 —102 xd		
55,000	United River Plate Telephone, Limited	5	4⅛— 5	4⅛— 5		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94 xd	90 — 94 xd		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ... xd	... ... xd		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9½— 10⅛	9½— 10⅛	10	...
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	101	99⅛
30,000	West Coast of America Telegraph, Limited	10	6 — 6½	6¼— 7	6¼	6
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	108 —112 xd	108 —112 xd	110	109
64,572	Western and Brazilian Telegraph, Limited	15	10 — 10½	9¾— 10⅛	10⅛	10
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 7	6¼— 7		
26,986	Do. do. do. 5 p. c. Deferred	7½	3¼— 4	3¼— 4	4⅞	4 13/16
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅝— 2⅞	2⅝— 2⅞	2⅞	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11 — 11¼	11 — 11¼		
4,669	Do. do. do, 6 p. c. 2nd Preference ...	10	12⅛— 13⅛	12⅛— 13⅛		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1⅝— 2¼	1¼ — 2		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6¼ paid), 7⅛—7⅜.—Electric Construction Corporation (£10 paid), 9¾—10¼. —House-to-House Company (£5 paid), 5—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2¼—2⅜.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

BANK RATE OF DISCOUNT.—4 per cent. (26th June, 1890).

WILLIAMS'S SELF-AMALGAMATING ZINC.*

THE usual method of amalgamating battery zincs is by immersing them in a suitable acid mixture to clean their surfaces, and then spreading mercury over the surfaces which have been cleaned by the action of the acid mixture. The film of mercury on the zincs gradually disappears during the action of the cells and must be renewed by re-amalgamating or by keeping a quantity of mercury in contact with the zincs, usually in the bottom of the cells in which the zincs stand.

To avoid the trouble of frequent re-amalgamation, Dr. James B. Williams, of this city, has recently designed and patented a zinc which is self-amalgamating, and which is accomplished without removing the zincs from the cells.

The accompanying illustration gives a clear idea of the method employed by Dr. Williams as applied in the case of the plain cylindrical zinc. The cavity containing mercury, M, is formed entirely in the substance of the zinc. From near the bottom of the cavity a canal, *i*, runs obliquely in an upward direction, and its opening, *o*, is on a portion of the surface of the zinc which is

below the level of the battery solution. Another canal *h*, runs in an upward direction and terminates on a portion of the surface of the zinc which is outside the battery solution. The purpose of the canal, *i*, is to allow the battery solution to have access to the mercury in the bottom of the cavity, and that of the canal, *h*, to allow mercury to be poured into the cavity without removing the zinc from its cell. The cavity and its outlets are formed in the zinc during the process of casting or by drilling.

To prepare the zincs for use, they are first amalgamated in the usual manner, a quantity of mercury placed in the cavities, and the zincs placed in their cells. If the zinc bodies are used, they are first fastened to their zincs and amalgamated with them in the usual manner, and a quantity of mercury placed in their cavities, after which they are placed in their cells. The mercury is renewed from time to time, as the film of mercury on the zincs is removed during the action of the battery. The zincs continue to be self-amalgamating until the zinc is dissolved to such an extent that the cavity will no longer retain the mercury which is poured through the canal, *h*.

* *Electrical Engineer*, New York.

NOTE ON A NEW PHOTOMETER.*

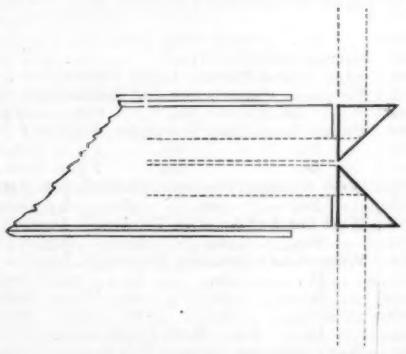
By EDWARD L. NICHOLS.

METHODS of photometry, which take no cognizance of differences of quality, are so ill adapted to the study of sources of light which differ from each other widely in temperature, that the introduction of some instrument by means of which both the character and intensity of an illuminant can be readily determined, would be a desirable adjunct to the equipment of our photometer rooms.

The instrument which it is my purpose to describe, has been designed to meet this need. Existing types of the spectrophotometer may be made to give good results, but they are expensive instruments, and so difficult to use that it is only in the hands of observers of considerable experience that accuracy is assured.

The new apparatus, the "horizontal slit" photometer, is, in point of fact, a spectrophotometer, in which the polarising device is entirely done away with. In it the extremely simple principle of the Bunsen photometer is applied successively to the various regions of the visible spectra of the source of light which are to be compared. A direct vision spectroscope of Browning's form is attached to the usual car of a Bunsen photometer, from which the disc and mirrors have been removed. The optical axis of the collimator is horizontal and at right angles to the photometer bar. The slit is horizontal and lies in a straight line joining the sources of light, which are set up in the usual manner at the ends of the bar. The bar itself is preferably of considerable length—in the case of the one upon which the original instrument under consideration was mounted it was 500 c.m. long—and should be divided into 1,000 equal parts.

In front of the spectroscope slit are placed two right angled prisms of the same size, and made of the same glass (see cut). Their vertical adjacent edges bisect the slit, and light travelling from either end of the photometer bar is totally reflected by them, and enters the right and left hand end of the slit in a direction parallel to the optical axis of the collimator tube.



The two sets of rays thus gathered into the spectroscope from the lights at the end of the bar are vertically dispersed by the Amici prisms, and appear in the field of view as two vertical spectra standing side by side. Equal wave lengths are in the same horizontal line, and any desired region may be brought into the centre of the field by an angular movement of the occular telescope. The telescope moves along the arc of a suitably divided semicircle, to which it may be clamped by means of a set screw. Wave lengths, corresponding to the various circle settings, are determined once for all by observation of the more prominent of the Fraunhofer lines.

When the instrument thus mounted is placed at the middle of the photometer bar between lamps which are identical in intensity and quality, the two spectra are of

* Read at the Annual Meeting of the American Institute of Electrical Engineers, Boston, May 20th.

equal brightness throughout, wave length for wave length, from red to violet. If the two lamps differ in intensity but not in quality, the two spectra will differ in brightness by the same amount from end to end, and a position may be found upon the bar for which they will be identical throughout.

Under these circumstances, which are the only ones in which the Bunsen method in photometry is strictly applicable, the instrument may be used as a simple photometer, the setting for any wave length whatever giving the candle-power. For this purpose alone, viz., for the comparison of lights of similar character, the instrument offers certain manifest advantages over the various forms of the Bunsen photometer. In the course of the present paper I shall present some definite data concerning the relative sensitiveness of the two instruments when used in this way.

When the lights to be compared differ both in intensity and quality, ordinary photometric indications possess no perfectly definite significance. In this, which is the more general case, the relative brightness of the spectra of the two sources varies with the wave length. For each region of the visible spectrum, however, a position upon the photometer bar can be found at which the brightness of the two spectra in that region will be equal, and the observations thus obtained, when extended over the entire spectrum, will afford data by means of which the differences in quality of the two sources of light may be definitely expressed.

In a recent paper read before the institute (*Transactions of the American Institute of Electrical Engineers*, Vol. VI., p. 183), for a considerable range of temperature at least, the ratio between the intensities of a certain wave length of the spectrum of glowing carbon, is identical with the ratio of candle-powers, as determined by the Bunsen photometer. The wave length in question, determined from the intensity of the spectrum of incandescent lamps at various candle-powers, I had found to be approximately $\lambda = 600$. M. A. Crova, in an important paper since presented at the late electrical congress at Paris,* has pointed out the importance of this method of measuring the light from sources differing in temperature The wave length which he has indicated for this purpose is $\lambda = 582$, which belongs to a region lying slightly farther toward the green than the one which I had adopted.

When the wave length of this region has been established beyond question, the photometry of lights which vary in colour, will have been reduced to a definite scientific basis. Instead of attempting to use the Bunsen photometer in measurements to which it is not adapted, we shall be able to deduce the relative candle-power of two sources of light from the comparison of a single wave length, and we shall be freed from the uncertainty arising from differences of colour and from the personal errors due to the independent use of the two eyes in observation. The determination of candle-power will then be an operation of precision, even when the sources of light to be compared vary widely in temperature. It is in the opportunity of performing such observations upon the photometer bar itself, under conditions which do away with many of the sources of error inherent in the usual methods of spectrophotometry, that the chief advantage of the new photometer will be found to lie.

The following set of observations, taken with the new instrument, may serve to indicate one of the uses to which it may be put. The data are taken from an investigation now in progress in the physical laboratory of Cornell University. The object in view was to compare the spectrum of a novel type of gas burner with that of an ordinary argand burner. The two lamps were set up at the ends of a photometer bar five meters long, the bar, as already stated, being divided into 1,000 equal parts. Readings were taken at six points in the spectrum. The purposes being to express the relative brightness of the two spectra, wave length for wave length; the intensity of that due to the argand burner was taken as unity throughout, and the brightness of each region of the spectrum of the flame under investigation was obtained in terms of that of the corresponding region of the spectrum of the argand. The results are given in Table I.

TABLE I.

Comparison of the spectrum of a Welsbach burner with that of an ordinary argand burner by means of the "horizontal-slit photometer."

Colour.	Wave length.	Light ratio, $\frac{\text{Welsbach}}{\text{Argand}}$.	Probable error of a single observation.
Red	702	0·709 ± ·017	2·45 per cent.
Yellow	589	1·476 ± ·017	1·14 „
	558	1·760 ± ·023	1·34 „
Green	500	2·395 ± ·047	1·99 „
Blue	466	2·738 ± ·036	1·30 „
Violet	439	3·090 ± ·073	2·35 „
			1·76 „ (Average)

From observations by Miss Ida M. Hill.

Ten observations were made in each region.

I introduce these measurements here simply as an illustration of one line of work to which the instrument under consideration is adapted. A full description of the research of which they form a part, and which covers many other questions pertaining to the very interesting class of lamps with which it deals, will doubtless be published in due time.

As will be seen from the column of probable errors the sensitiveness of the instrument is greatest in the region of the D line ($\lambda = 589$), and least in the extreme red and violet, where the light intensities are small.

A set of ten determinations made by the same observer with the Bunsen photometer gave for the total light ratio of the two lamps:

$$\frac{\text{Welsbach}}{\text{Argand}} = 1{\cdot}701 \pm 015$$

The probable error of a single observation in this series amounted to 0·89 per cent., a value somewhat smaller than that obtained with the new photometer in the yellow of the spectrum.

The number of observations is too small to afford a close estimate of the relative sensitiveness of the two instruments, but the results suffice to show that the "horizontal slit" photometer does not differ appreciably in accuracy from the Bunsen photometer when the latter is used in the comparison of flames of the same colour.

When it comes to the measurement of sources of light that differ widely in temperature the comparison is decidely in favour of the "horizontal slit" photometer, the sensitiveness of which is not affected by differences of colour. The error of the Bunsen photometer in candle-power measurement of the arc light, for instance, calculated from ten observations recently made upon the same photometer bar, the reference standard being an argand gas burner, was 2·65 per cent. (probable error of a single observation), a value more than twice as large as that of the "horizontal slit" photometer.

A comparison of the performance of the new photometer with that of a polarizing spectrophotometer of the type which is commonly recognised as affording the highest degree of accuracy, is decidedly in favour of the former. Taking as a basis eight observations made by Mr. Franklin and myself in the study of a bat's-wing gas burner,* the observations covering eight regions of the spectrum, I find the error of a single

* M. A. Crova, *La Lumière Electrique*, Vol. XXXIII., p. 478.

* *American Journal of Science*, Vol. 38, p. 100. See also *Transactions of the American Institute of Electrical Engineers*, Vol. 6, p. 177.

observation in the various regions to have been as follows :

TABLE II.

Probable errors of a single observation with a polarising spectrophotometer, calculated from sets of 10 observations upon various portions of the spectrum of a gas flame.

Wave lengths.		Probable error of a single observation.
753	...	7·9 per cent.
668	...	4·9 " "
608	...	4·5 " "
557	...	5·4 " "
518	...	6·4 " "
492	...	7·0 " "
468	...	3·0 " "
450	...	2·4 " "
		5·2 per cent. (average).

The measurement of a fluctuating illuminant, such as the gas flame, is a line of investigation by no means adapted to exhibit any photometric instrument at its best; but as the errors of the horizontal-slit photometer, already given, were calculated from sets of 10 observations upon such flames, I have selected for comparison similar sets of 10 upon sources of the same character.

The averages, viz. :—

Error of horizontal-slit photometer 1·76 per cent. (average for spectrum). Error of polarising spectrophotometer 5·20 per cent. (average for spectrum) doubtless afford a fair indication of the relative performance of the two instruments in this peculiarly trying line of work.

At the last annual meeting of the Institute I had the privilege of presenting a brief study of certain personal errors pertaining to the use of the Bunsen photometer. The particular class of errors to which attention was called in that paper are undoubtedly obviated by the use of the horizontal-slit photometer; what new ones the latter instrument may introduce remains to be determined.

ON THE ELECTRO-DEPOSITION OF PLATINUM.*

By WM. H. WAHL.

THE permanence and unalterability of the metal platinum—properties which make it of such inestimable value to the chemist—have likewise suggested its application as a protective covering upon the surfaces of other metals; and, even in the early days of the art of electro-deposition, efforts to obtain a satisfactory coating of this metal were made. The failure with which these early experiments were attended served rather to stimulate than to deter subsequent investigators, and the problem has received the attention of a number of the most noted experts in the art. The results that have been accomplished cannot be said to have been entirely satisfactory—a statement which, I believe, will be fully sustained by the fact that electro-plating with platinum, on the commercial scale, is practised only to a very limited extent. When the wide field of application for platinum-plating is considered—and I need only name philosophical, engineering, surgical, dental and electrical apparatus and instruments, fire-arms, watch-cases, and jewellery, to say nothing of the host of miscellaneous articles of utility and ornament to which the metal could be advantageously applied—the conclusion is irresistible, that the processes thus far proposed for the purpose do not fully meet the requirements of practical service.

Thus far, of all the methods that have been proposed for electro-plating with platinum, three only appear to have sufficient merit to deserve special notice; these are :—

1. Roseleur-Lanaux method, based on the electrolysis of a solution of the double phosphate of sodium and platinum.

2. The process of the Bright Platinum Plating Company, of London, a modification of that of Roseleur, involving the introduction into the bath of certain substances, such as sodium chloride and borax, to ensure a bright deposit of the metal; and

3. Boettger's method, founded on the electrolysis of a solution of the double chloride of ammonium and platinum in sodium citrate.

Each of these baths will yield satisfactory results for a time; but, as I shall endeavour to show, the peculiar difficulties met with in the practice of platinum-plating render it impossible to maintain the chemical integrity of these electrolytes, and, in consequence thereof, they soon become inefficient or inoperative by reason of contamination with the secondary products formed therein.

I will endeavour in what follows to give the true explanation of the difficulties above referred to, and to indicate what, from a careful study of the subject, fortified by the results of numerous experiments, I conceive to be the only feasible method of overcoming them.

The first difficulty encountered is that of obtaining a bright, reguline and adherent deposit of the metal, in which form only it will answer the demands of practice. There is no difficulty in effecting the separation of the metal from solutions of almost any of its compounds. Zinc, iron and tin reduce it promptly by simple immersion, and this very facility of reduction is one of the reasons why, even by the method of electrolysis, the desired object is frequently accomplished only in an imperfect manner; for the electroplater is obliged to meet and overcome its obstinate disposition to separate from many of its compounds in the condition of platinum black, lacking coherence and adherence, and therefore entirely unsuited for his purpose.

Another and no less serious difficulty arises from the insolubility of plates or sheets of this metal as anodes, when solutions containing platinum salts are submitted to electrolysis. In electro-plating with copper, silver, gold and nickel, but little difficulty is encountered in practice on this account, since anodes of these metals are freely soluble in many solutions capable of depositing them when they are submitted to electrolysis, and the rate at which these anodes are respectively dissolved, approximates so nearly to that at which the metals are deposited upon the objects at the cathode, that the metallic strength of the electrolyte is maintained substantially uniform, and electro-plating solutions of these metals may be operated for a long time without requiring additions of metallic salts. The electro-deposition of the metals whose anodes are thus tractable is carried on industrially with success.

It results from this want of solubility of the anode that the metallic strength of the electrolyte employed is continuously being weakened, while the deposition of the metal is going on, and the conductivity of the bath is being continually modified thereby. The character of the deposited metal also is injuriously influenced by these constant alterations of condition in the bath; and, as the rate of deposition becomes slower and slower by reason of the gradual impoverishment of the metallic strength of the solution, it will be necessary to restore it by fresh additions of metallic salt. The practice in all the processes of electro-plating with platinum employed up to the present time, save that of Boettger, is to use for this purpose the tetra-chloride of platinum. With this single exception, all the solutions for the electro-deposition of platinum thus far made known, so far as I am aware, are made by treating the chloride with compounds of the alkalies, soda, potassa, or ammonia. Of these, the phosphates and oxalates of soda, or potassa, are in greatest favour, and a number of formulæ for preparing platinum-plating baths with their aid have been described. The resulting sub-

* Read at the Stated Meeting of the Chemical Section, Franklin Institute, May 20th, 1890.

stance is commonly a double salt, such, for example, as the double phosphate of sodium and platinum; the double oxalate of potassium and platinum, &c., contaminated, however, in each case by the chloride of the alkali employed, which is formed from the decomposition of the platinic chloride. As often as it is found necessary to strengthen the bath, fresh additions are made of platinic chloride, which, by chemical interaction with the constituents of the bath, aided by the process of electrolysis, yields more alkaline chloride; and it follows that the bath, by reason of becoming surcharged with this foreign substance, and with other secondary products of electrolytic decomposition, ceases to yield bright, reguline platinum upon the articles to be plated therewith, and must be discarded. It then becomes necessary to regain the platinum contained in the discarded bath, by one or another of several processes of reduction known to chemists. The platinum thus regained may be converted into chloride and utilised in the preparation of a fresh bath, with which the same series of operations will be repeated. Boettger purposes to maintain his bath by fresh additions of his original solutions, but it must be apparent that the continued electrolysis of such a solution as he employs must be attended with the constant accumulation therein of alkaline chlorides from the same causes as those specified above. This rapid deterioration of the baths, therefore, involve their frequent renewal at the expense of time and labour, so that, in spite of the fact that there is a wide field for its application, it is principally for this reason that the art of electro-plating with platinum on the commercial scale has thus far been practised only to a very limited extent.

It occurred to me that it might be practicable to overcome the principal difficulty here set forth. Knowing the influence of extent of surface in promoting the solubility of substances, it appeared to me at least probable that if the platinum were exhibited at the anode in the form of platinum black, or sponge, exposing thus an enormously greater number of points of attack to the electro-negative element or acid radical there set free, the result might be the solution of the platinum, and the problem of maintaining the metallic strength of the electrolyte would thus be solved. The correctness of this conjecture was verified by experiment. For this purpose a plate of porous battery carbon, previously treated with boiling hydrochloric and nitric acids, was saturated repeatedly with a solution of platinic chloride and dried. It was then introduced into a graphite crucible, finely divided carbon was packed about it, and the crucible and contents heated for about half an hour to bright redness. The carbon plate then contained within its pores platinum in a state of eminently fine division. Treatment with water, and with hydrochloric acid at boiling temperature, failed to leach out any platinum salt, showing that the previous treatment had sufficed to reduce all the platinum salt to the metallic state. The carbon plate was then suspended as the anode in moderately diluted hydrochloric acid, a platinum plate serving as the cathode. The acid bath was gently heated and a current of moderate strength was allowed to flow through it. There was a liberal evolution of hydrogen from the cathode, but little perceptible evolution from the anode. The acid solution gradually became coloured from the formation of platinic chloride, and after some time the bright surface of the cathode began to blacken and ultimately became covered with a thick coating of platinum black. It was thus demonstrated that an anode of platinum in a fine state of division is readily soluble in an electrolyte which yields chlorine at the anode when the same is electrolysed. This observation, so far as I am aware, is new. It proved, however, to have no practical value, since the solution of the anode demanded the presence of a large proportion of free acid in the plating-bath, and the use of currents of such strength as to produce invariably the deposition on the surfaces to be plated of black and non-adherent metal. Furthermore, it was found, as was to have been anticipated, that the physical condition of the anode exerted no influence whatever in the electrolysis of baths formed of the oxy-salts of platinum, from which the best results in electro-plating are obtained—since, in electrolysing such compounds, the acid radical separated upon the surface of the platinum black failed to exert any perceptible solvent action.

It was therefore necessary to devise some other plan for overcoming the difficulties herein described, and, after making a number of fruitless experiments, I was so fortunate as to find a plan which appears to offer a solution of the troublesome problem of electro-plating with the group of metals, whose anodes are insoluble, in a more satisfactory manner than any other that has hitherto been suggested.

The plan here referred to consists in employing platinum hydroxide for the purpose of maintaining the metallic strength of the plating bath. For this purpose, the hydroxide, which is readily soluble in alkalies and in many of the acids, may be introduced into the plating bath from time to time and dissolved therein by stirring, or it may be permitted to remain in the bath in excess, the undissolved portion remaining at the bottom of the containing vessel, or it may be suspended in a canvas bag adjacent to or surrounding the anode of carbon, according as the nature of the electrolyte may indicate one or the other method to be the preferable one. As the solutions which yield the best results in plating are those of the oxygen salts, I have found it advantageous also to prepare these directly from the hydroxide. This method, I have found, is capable of yielding a number of electrolytic baths of platinum that will maintain their metallic strength approximately unimpaired during electrolysis, and without the objectionable features of introducing into them substances that will cause them to deteriorate by the accumulation therein of injurious secondary products of decomposition, as is the case where such baths are maintained by additions of platinic chloride or alkaline chloro-platinates, as has hitherto been the invariable practice. Referring now specifically to the properties that render the platinic hydrate useful for the purposes above indicated, the following points appear to be deserving of mention.

It is readily soluble in aqueous solutions of the alkaline hydrates, and in a number of acids, mineral and vegetable. In the treatment of the platinic hydrate with aqueous solutions of the alkaline hydrates, the former plays the part of a weak acid forming compounds known as platinates, which are very soluble, and from which the platinum is not precipitated on the addition of an excess of alkali. A weak aqueous solution of sodic or potassic hydrate (but especially the last-named) will dissolve a large quantity of platinic hydrate, at the ordinary temperature, though solution takes place more freely when heat is applied. These solutions have the advantageous features of being freely conductive of electricity, and of yielding bright, reguline and adherent electro-deposits of platinum on metallic surfaces previously prepared to accept the same. Furthermore, with a current of moderate strength, the platinic hydrate only is affected, as is shown by the pronounced evolution of oxygen at the anode, and by the total absence of gas at the cathode. Also, it is manifest from the free solubility of platinic hydrate in alkaline hydrate, even in the cold, that if free platinic hydrate be present in a bath of alkaline platinate, the alkali set free in the process of electrolysis will combine with this platinic hydrate to form fresh platinate. For this purpose it will be necessary either to have present in the bath at all times a small excess of platinic hydrate which may remain upon the bottom of the containing vessel, without interference with the plating, and which may be replenished from time to time; or to introduce, at the end of the day's work, a quantity of the platinic hydrate sufficient to restore the metallic strength of the bath to normal, assisting the solution of the metallic hydrate by stirring, and, if necessary, by the application of gentle heat. As I have found that the platinate solutions act best when they contain a considerable excess of free alkaline hydrate, being more conductive of the current and yielding the platinum more freely and in the best condition, the addition of the proper quantity

of platinic hydrate at the close of the day's work in the case of a bath of considerable volume, or the addition of small quantities at intervals, in the case of a small bath, will be found to answer the desired purpose of maintaining the metallic strength of the bath approximately normal for an indefinite period. In a bath where considerable free alkali is present the platinic hydrate added, as just indicated, dissolves very freely even in the cold. The important fact is to be noticed that the alkaline platinate solutions may be maintained and operated for a long time in the manner described, since no deleterious secondary products are formed by electrolysis to vitiate and render them inoperative, as will speedily be the case where the platinic chloride is used for this purpose. The mineral acids (hydrochloric, nitric, sulphuric, and phosphoric acids) dissolved the hydroxide freely, as likewise do certain of the vegetable acids, notably oxalic acid, and form with corresponding salts of the alkalies, double salts, many of which are soluble in water. Of the salts thus capable of being formed, however, so far as I have been able to determine by experiment, only a limited number appear to be adapted to yield a deposit of bright, reguline and adherent platinum. The halogen compounds may obviously be prepared more conveniently by the direct solution of the metal in *aqua-regia* than by the method I have described, but as I have found the oxygen compounds of platinum to yield much more satisfactory results, I therefore exclude them from consideration.

Of the salts that may be formed from platinic hydrate by solution in acids (and in part by suitable combination with the corresponding alkaline compounds to form double salts), three only may be named as sufficiently useful to yield practically valuable results in plating. These are the phosphates, oxalates and acetates, of which also it is practicable to form double salts with the alkalies, soda, potassa and ammonia, which yield bright, reguline and adherent plating.

Oxalic acid, so far as I have been able to determine, of all the oxygen acids, is the best solvent of platinic hydrate, dissolving it even in the cold, but with great energy when aided by heat, and forming platinous oxalate, with evolution of carbonic anhydride. From this brownish-black or deep blue solution (according to concentration), brilliant reddish-brown scales of the salt separate abundantly and readily from the hot saturated solution. A saturated aqueous solution of the simple oxalate prepared from the hydrate, as above described, will yield bright, reguline, adherent platinum when electrolysed with a comparatively weak current, with evolution of carbonic anhydride at the anode. With a stronger current hydrogen also appears at the cathode. This bath may be maintained indefinitely at normal metallic strength by observing the precaution to add oxalic acid and platinic hydrate in small quantities from time to time; or by keeping constantly at the bottom of the bath some platinic hydrate, and adding oxalic acid in crystals or powder from time to time as may be required to keep the bath saturated; or, what is much to be preferred, making a supply of platinous oxalate from platinic hydrate in the manner previously described, and keeping an excess of this present in the bath at all times. This bath has the same advantages as are possessed by the above-described alkaline platinate baths, of being capable of indefinite maintenance at normal metallic strength, and of introducing no substances that will cause its deterioration by the formation of secondary decomposition products.

Phosphoric acid also is a solvent of platinic hydrate. A dilute aqueous solution of this acid will dissolve a small quantity of the metallic hydrate in the cold, and a much larger quantity when aided by heat. With increasing concentration, the solvent power of this acid for platinic hydrate is correspondingly increased. The resulting solution of phosphate of platinum, according to the degree of concentration, will be wine-yellow to cherry-red in colour, and with a comparatively weak current, will yield bright, reguline and adherent platinum on metallic surfaces properly prepared to accept the same. The electrolysis of this compound, also, does not involve the formation of deleterious secondary products, the result of the operation being the separation of the metal at the cathode, and of the acid radical at the anode—and of the elements of water which are evolved as gases respectively from anode and cathode. In the operation of the bath, therefore, it will become more and more acid as the metal is withdrawn by the accumulation therein of the phosphoric acid set free at the anode. The maintenance of the metallic strength of the bath, therefore, may be effected as in the foregoing cases, by having present therein at all times a small quantity of platinic hydrate, or by the addition at the end of each day's work of the quantity of the metallic hydrate which will be required to restore the amount of metal withdrawn. This bath must be worked very acid, and the solution of the platinic hydrate to maintain the strength of the bath must be facilitated by heating, as the solvent power of phosphoric acid for platinic hydrate is much inferior to that of oxalic acid. The double phosphates of platinum with certain of the alkalies may be formed, which will be capable of yielding a deposit of bright, reguline and adherent metal, and of being maintained approximately at normal metallic strength in the same manner as I have set forth above. The best results I have obtained with the ammonio-platinic phosphate, prepared by adding to the solution of platinic hydrate in phosphoric acid sufficient aqua ammoniæ to cause the same to give an alkaline reaction, which point will be indicated by the formation of a grayish precipitate that will not disappear on stirring; then restoring the acidity of the solution by adding free phosphoric acid in excess, upon which the precipitate readily dissolves. The resulting solution is yellowish or brownish, and yields superb plating; though, on account of the greater difficulty of maintaining its metallic strength by the solution of the hydroxide, it is not so well adapted as the oxalate for the work of electro-deposition on the large scale. The sodio-platinic phosphate, formed in a manner precisely analogous to the ammonia compound just described, will also yield bright, reguline and adherent plating; but I have observed that the soda salt is less freely soluble than the corresponding ammonia compound, and consequently more difficult than the latter to maintain of normal metallic strength.

Platinic hydrate is only very sparingly soluble in strong acetic acid, and it is impracticable to facilitate the solution by boiling, since by persisting in this for a very short time, the hydrate is decomposed, and black platinic oxide is formed, which is quite insoluble in this menstruum. I have found, however, that an alkaline acetate bath may be prepared by the addition to the alkaline platinates above described, of as much acetic acid as may be introduced without causing the formation of a permanent precipitate. But although the appearance and quality of the plating obtained with this bath leave nothing to be desired, the bath does not meet the requirements in respect of indefinite maintenance in normal metallic strength and uniform composition. This difficulty, however, as I have observed, becomes less and less pronounced as the bath is made more strongly alkaline, when it approximates more and more closely to the alkaline platinates; for it is obvious that in the presence of a large amount of free alkali, this would unite with the acetic acid to form a simple acetate. The resulting solution would no longer contain sodio- (potassio-) platinic acetate, but sodic (potassic) acetate, sodic (potassic) platinate, and free alkali. Nevertheless, the presence of acetic acid in such alkaline bath appears favourably to influence the quality of the plating yielded, giving the deposited metal a whiteness approaching that of silver; and since, furthermore, acetic acid yields only the elements of water and volatile compounds when electrolysed, and therefore does not contaminate the electrolytic bath by forming deleterious secondary products, I find its judicious addition to the above-described alkaline platinate baths to present some advantages.

The foregoing comprise the compounds that I have found to yield the most satisfactory results in platinum

plating, and I will not tax your patience at this time by an enumeration of the results, either partially successful or wholly unsuccessful, that I have obtained with a number of differently constituted compounds of this metal.

I append directions for the preparation of the several electrolytic baths above described, and indicate what I have found to be the most favourable conditions for working them.

In conclusion, I desire to make known the fact, which was brought to my knowledge only within the past week, that my friend, Prof. Wm. L. Dudley, of Vanderbilt University, Nashville, Tenn., has independently worked out the problem of electro-plating with iridium in a manner precisely analogous to that which I have herein described with platinum. Prof. Dudley has made no publication of his research, but in a letter informs me that he employed, as long ago as 1886, the following procedure, which I quote, "a bath of the metal may be composed of either the chloride ($IrCl_4$), the double chloride of iridium and sodium, a double sulphate of iridium-ammonium. The latter was preferred. The bath was kept saturated with metal by suspending canvas bags in the solution (either near to or around the anodes) containing the hydroxide of iridium."

Directions for Preparing the Electro-Plating Baths.—For the alkaline platinate bath, the following directions may suffice :—

Platinic hydrate	2 oz.
Caustic potassa (or soda)	8 oz.
Distilled water	1 gallon.

Dissolve one-half of the caustic potassa in a quart of distilled water ; add to this the platinic hydrate in small quantity at a time, facilitating solution by stirring with a glass rod. When solution is effected, stir in the other half of alkali dissolved in a quart of water ; then dilute with enough distilled water to form one gallon of solution. To hasten solution, the caustic alkali may be gently heated, but this is not necessary, as the platinic hydrate dissolves very freely. This solution should be worked with a current of about two volts, and will yield metal of an almost silvery whiteness upon polished surfaces of copper and brass, and quite freely. There should be slight, if any, perceptible evolution of hydrogen at the cathode, but a liberal evolution of oxygen at the anode. I have observed that the addition of a small proportion of acetic acid to this bath improves its operation where a heavy deposit is desired. The anode may be of platinum or carbon, and owing to the readiness with which the metal is deposited an excess of anode surface is to be avoided. Articles of steel, nickel, tin, zinc, or German silver, will be coated with black and more or less non-adherent platinum ; but by giving objects of these metals a preliminary thin electro-deposit of copper in the hot cyanide bath, they may be electro-platinised in the alkaline platinate bath equally as well as copper. The bath may be worked hot or cold, but it is recommended to work it at a temperature not exceeding 100° F. It may be diluted to one-half the strength indicated in the formula, and still yield excellent results. The surface of the objects should be highly polished by buffing, or otherwise, prior to their introduction in the bath, if the resulting deposit is designed to be brilliant.

The deposition of platinum takes place promptly. In five minutes a sufficiently heavy coating will be obtained for most purposes. The deposited metal is so soft, however, that it requires to be buffed very lightly. A heavier deposit will appear gray in colour, but will accept the characteristic lustre of platinum beneath the burnisher.

The oxalate solution is prepared by dissolving one ounce of platinic hydrate in four ounces of oxalic acid, and diluting the solution to the volume of one gallon with distilled water. The solution should be kept acidified by the occasional addition of some oxalic acid. The simplest plan of using this bath, and which requires no attention to proportions, is simply to work with a saturated solution of the oxalate, keeping an undissolved excess always present at the bottom of the vessel. An addition of a small quantity of oxalic acid now and again will be found advantageous. The double salts of oxalic acid with platinum and the alkalies may be formed by saturating the oxalate of the desired alkali, with platinic hydrate and maintaining the bath in normal metallic strength by the presence of an undissolved residuum of platinous oxalate.

The double oxalates are not so soluble in water as the simple salt. The oxalate baths, both of single and double salts, may be worked cold or hot (though not to exceed 150° F.), with a current of comparatively low pressure. The metal will deposit bright, reguline and adherent on copper and brass. Other metallic objects must receive a preliminary coppering as above. The deposited metal is dense, with a steely appearance, and can be obtained of any desired thickness.

The deposit obtained in the oxalate baths is sensibly harder than that from the alkaline platinate bath, and will bear buffing tolerably well.

The phosphate bath may be prepared by the following formula :—

Phosphoric acid, syrupy (sq. gr. 1·7)	8 oz.
Platinic hydrate	1–1½ oz.
Distilled water	1 gallon.

The acid should be moderately diluted with distilled water, and the solution of the hydrate effected at the boiling temperature. Water should be added cautiously from time to time to supply that lost by evaporation. When solution has taken place the same should be diluted with sufficient water to make the volume one gallon. The solution may be worked cold or warm to 100° F., and with a current much stronger than that required for the platinates and oxalates. The ammonio- (and sodio)- platinic phosphates may be formed from the simple phosphate by carefully neutralising the solution of the phosphate with ammonia (or soda), then adding an excess of phosphoric acid, or enough to dissolve the precipitate formed, and an additional quantity to ensure a moderate amount of free phosphoric acid in the bath. The phosphate baths will be maintained of normal strength by additions of platinic hydrate, the solutions of which will have to be assisted by heating the bath, preferably at the close of each day's work. The metal yielded by the electrolysis of these phosphate solutions is brilliant and adherent. It has the same steely appearance as that exhibited by the oxalate solutions, but to a less pronounced degree. The physical properties of the deposited metal are in other respects like those described in connection with that obtained from the oxalate baths.

THE PROGRESS OF ELECTRICAL TRACTION.*

By Dr. LOUIS BELL.

THE beginning of electrical traction, or rather of its possibility, dates from that magnificent discovery of the reversibility of the dynamo, a discovery that, perhaps, cannot be ascribed to any one person or to any definite year ; it was in the air during the sixties, as the telephone was in the succeeding decade ; but it was not until 1873, at the Vienna Exhibition, that the possibilities of this discovery were realised. Nothing came of its except occasional applications until Dr. Werner Siemens saw all the possibilities of the motor for railroad use, and in 1879 the first modern electric railroad was built at the Berlin Exhibition. Here for the first time a moving motor was supplied with power from a distant dynamo. The current was led to the motor car through a third rail and back to the ordinary track. Very shortly afterward the experiments began in this country, first, perhaps, in the hands of Mr. Field, and

* Abstract of paper read before the Scranton Science Club America, June 19th, 1890.

almost simultaneously at the laboratory of that incorrigible inventor, Edison. Two years more saw the opening of the Siemens electric road from Lichterfelde, a suburb of Berlin, into the outskirts of the city. Unless temporarily stopped, that road, the first practical electric road in the world, is running to-day.

Given an electric motor and a car, how can they be combined? This was the first question to be raised. Where should the motor be put, and how should it be connected with the driving wheels? Almost every conceivable spot in and about a car had been tried as a place for the motor—on the platform, in the car, on top of the car and under the car, in almost any position that could be named. Not until the present method of swinging the motor from the car axle, so that the armature would be at all times equidistant from it, was devised, were thoroughly practical results secured. But the great difficulty in the way of using the electric motor is one which at first sight does not suggest itself—the high speed at which the motor ordinarily runs. It has been up to the present quite out of the question to build a light and efficient motor in which the armature should revolve at a low speed; I mean by that, 100 revolutions per minute, or something of the kind. With the ordinary motors running from 800 to 1,200 revolutions per minute, it is obviously absolutely necessary to reduce the speed by some kind of gearing in applying it to a car axle; for if this were not done the speed of the car would be preposterously great. Within the last ten years almost every known mechanical means for reducing speed has been applied to the problem; belts, chains, ropes, worm-gearing and every description of toothed gear has been pressed into service, but one after another has been discarded as impracticable, until at the present nearly all electric cars are operated by plain toothed gearing. In the existence of this lies one of the difficulties that must be overcome in the future.

The first electric road utilised the rails; but for street traffic this is inconvenient, and all sorts of overhead arrangements were schemed, experimented on and abandoned. Cars running on an overhead wire and dragged by wires from the car were and are still in use. Copper tubes slotted beneath were employed in which the car dragged along a wire brush much after the similitude of a gun cleaner. Then came every description of under running trolley from a wire broom that scraped and ground along the conductor to the present smooth running little wheel.

Then another snag was encountered. After the electric current is led to the car, how can it best be conveyed to the moving parts of the motor? The ordinary brushes such as we see on the commutators of dynamos answer the purpose admirably except for one inconvenient fact, that it is necessary to run the armature of a motor in more than one direction, as when the car is on the return trip, and the copper brushes that worked admirably well when the armature revolved with them raised a blazing protest when the armature revolved against them. If I were asked what is the most important minor improvement in electric traction, I should say unhesitatingly that it is the introduction of the carbon brush that rests quietly on the surface of contact and is quite indifferent as to the direction of rotation of the commutator beneath it. Aside from these fundamental difficulties minor ones were met at every point of the construction of an electric railroad. The trolley wire is necessarily under high tension, and only after elaborate experiments was the hard bronze wire now used found and adopted. Then this very tension brings a severe strain on the supporting poles, and all sorts of ingenious devices had to be invented to sustain and equalise it. The road that runs on your streets to-day is a result of an enormous mass of inventive ingenuity applied in directions of which it is impossible in a limited time to give any adequate idea. That the success which has been attained is so great is a standing monument to the perseverance and genius that have produced it. The electric car of 1890 is a machine that is marvellously successful, and in view of what is being done in every succeeding week, it is not too much to say that the horse's occupation in street car work is practically gone.

To-day the grinding gear wheels underneath the car constitute the most serious mechanical difficulty in electric railroading, and it should be the object of inventors to dispense with them if possible. It is possible, although it has not yet successfully been done, to build a motor of which the armature shall be directly upon the car axle, and that yet will operate with a fair degree of economy. This done and we should have a system of electric traction almost ideal in its simplicity; a single rotating armature grasped and centered between field magnets surrounding the axle, the current supplied to it from a movable contact, a switch to control it. That is all. And few people have any adequate idea of the mine of power that these same grinding cog wheels waste.

A question that is often asked is: Why is it necessary to put two 15 H.P. motors under a car of the same size that was previously drawn by a couple of mules. The question is a very pertinent one, though the answer is somewhat complicated. In the first place, it has been found convenient to run electrical cars at a great deal higher speed than horse cars, consequently to employ more power. In the second place, electrical roads operate with very heavy loads on grades that are tremendously severe, as steep as one foot in ten. All this requires still more power, but does not explain fully the discrepancy between these 30 H.P. motors and the aforesaid two mules. When we come to examine the power which is required to operate an electric car, taking the average of all day long, we find that the difference is not by any means so great. Somewhere from 3 to 6 H.P. is about the amount. A sudden spurt up a sharp grade will perhaps require half-a-dozen times this amount; and this is not disadvantageous, for a motor, like a mule, can, we see, pull very hard when it becomes necessary. But let us turn a little to experiments made with the view of answering the question I have raised. Most of our present electric cars have two motors, each with its appropriate set of gears, and it is an unfortunate fact that these two do not always pull together in the harmony that might be desired. There is a constant tendency for one or the other of them to do more than its share of the work, and, aside from this, the two sets of gears consume an outrageous amount of power, which, it should be remembered, does not go into any useful work but simply tends to heat and wear out the running parts. Experiments tried last winter in Colorado show the facts of the case very beautifully. A five-ton car operated with both motors at an approximate speed of 12 miles per hour required something like 6 H.P.; using only one motor, the horse-power required was reduced to five for about the same speed; and finally, removing the pinion from one of the armatures, so that the car was operated by one motor and only one set of gears, the power was reduced to something like $3\frac{1}{2}$, which, considering the load and the speed, is not at all too high. A pull of something like 20 pounds per ton is required on ordinary tracks; that is, the motors in this case were pulling 100 pounds at the rate of 12 miles per hour, which, reduced to foot pounds and then to horse-power, becomes about 3, which gives the motor that actually exerted about $3\frac{1}{2}$ horse-power a very reasonable degree of efficiency. So the cost would not be at all bad with one motor either on the axle or simply geared. It is pretty clear that there is a disadvantage in the use of two motors except in so far as it is convenient to drive both axles for ease of ascending grades, and it is no less evident that a considerable power can easily be lost in gearings.

The possibilities of electric traction are by no means exhausted in its application to street cars. I do not hesitate to say—and I say it deliberately—that to operate an ordinary railroad train by an electric locomotive is a far simpler problem, electrically and mechanically, than the operation of street cars here on the streets. The slow speed necessary for street cars is, as I have already said, a disadvantage in that it compels us to gear down the motor. In running at railway speed no such difficulty is encountered, for the four or

five hundred revolutions per minute made by the drivers of an express locomotive is just about the proper speed at which an electric motor of corresponding power could be advantageously run. We should then be enabled to dispense entirely with the obnoxious gearing and to put directly upon the axle of the driving wheels an armature big enough and powerful enough to generate the required speed. Nor is there any practical difficulty in building motors big enough to do the work. There are plenty of 100 H.P. dynamos now running, and the increase of size sufficient to duplicate the power of a locomotive is the simplest sort of mechanical operation. I do not think there is a prominent electrical company to-day that would hesitate to take an order for a 500 H.P. machine and guarantee its performance. I certainly know of several that would be glad of the chance and would accomplish the task successfully.

There is no sort of difficulty in conveying the current to one of these big motors moving at railway speeds, for it has been established by experiment that the method of running contacts such as is in general use will work admirably up to the speed of 130 miles per hour, at which speed an electric car of respectable dimensions has been actually operated. The question, then, of using the electric motor for railway work is not a question of mechanical or electrical difficulties but of economy. It is worth while noticing that in an electric locomotive the big machines can be given an amount of care quite impossible on our street cars, for the good reason that while the street car motor is exposed to the wet and dust and dirt to an enormous extent, in an electric locomotive the whole can be boxed up inside of a clean car and given practically as careful attention by the engineer as is now possible in a dynamo operated in a central station.

Now as to the question of economy. The steam locomotive, in its present stage of development, is a remarkably successful machine. Nevertheless, it does consume more coal proportionately than is used, for instance, in the engines of a big steamship like the *Umbria* or the *City of Paris*. It burns, in fact, between two and three times as much coal per horse-power of output. This is not due to any radical defects in the locomotive, which, all things considered, is a good and economical machine, but arises from the fact that the huge engines of the transatlatic liners are condensing engines, nearly always triple expansion, while the locomotive is a simple engine of a class that has been generally abandoned for steamship use. The principal advantage that we should gain by using large electric motors supplied from a central station instead of the present steam locomotives would be a much more economical use of coal. It is safe to say that the consumption of fuel for a given number of horse-power produced by big engines in an electric station could be reduced to less than half what is now used to supply a similar amount of power in the locomotive. To offset this advantage there is the necessary loss of power in conveying the current generated to the running motor. If the length of line to be operated from a single station is great, this loss may be considerable; but it is unquestionably smaller than the gain to be made in the way I have suggested. Beside this, the electric locomotive does not have to drag around its supply of coal and water.

There is, too, a magnificent possibility of economy in the use of water power. Very many of our railroad lines follow the course of some river, winding in and out along a valley; frequently there would be an abundant supply of water-power near at hand, and under such circumstances the cost of operation for an electric road would become enormously less than for the same line operated by steam. Of course, this is under favourable circumstances, and therefore we should not lay too much stress upon it; but I think it is clear to any one who is familiar with the operation of big condensing engines that their advantage in economy over a locomotive is so great as to make it worth while to distribute the power from them, even at a considerable loss. The amount of copper line wire necessary for such distribution is not at all unreasonably great; no greater, in fact, than the amount now used in trunk lines for long distance telephony; and there is every reason to believe that, taking into consideration all these things, an ordinary railroad could be operated by electricity at a cost less, or at least no greater, than is now incurred.

As the speed to be attained rises, electric power gains over its competitor; for a high-speed locomotive must carry an enormous amount of coal and have a boiler of prodigious capacity; while inasmuch as we do not have to move the fuel or boilers of a central station, their size is a matter of indifference. The speeds that are reached now with locomotives can be duplicated with motors without difficulty. I believe the present record for locomotive speed is 87 miles per hour, made this year on the Philadelphia and Reading Road, while last year, as I just mentioned, an electric car, small, to be sure, but at the same time running under some disadvantages as regards track, attained a speed of more than two miles per minute. In fact, economy aside, I do not see that we can set any limit to the running speed of a motor except that imposed by adhesion, the strength of the steel in the flying drivers to withstand the centrifugal force and the conditions necessarily imposed on the strength and smoothness of the track.

But this aside, let us cast a prophetic glance forward to the electric express train of the future. It may consist of a motor car, very likely pointed at the front to lessen the resistance of the air to its swift passage, and containing one or more powerful motors directly on the axis of its drivers and aggegating perhaps 1,000 H.P. as a nominal output. Following it the customary vestibuled procession of baggage cars, day coaches and sleepers of the ordinary size and number. Its only lights by night will be incandescent lamps; its only means of heating electric heaters distributed through the train; 10 or 15 extra H.P. are enough to furnish an adequate supply of heat. The track over which this train will run must be straight and smooth, not at all a marvellous track, but only such a one as the great English trunk lines possess to-day. A third rail or a strong bronze wire above will convey the current to the motors, and power for it all will be supplied by a series of stations perhaps 20 or 30 miles apart along the line. The train will start smoothly into motion, fly along the track at the highest rate of speed that is found practicable, and stop quickly and easily by applying its electric brakes. The system of distributing power can be easily converted into an automatic block system that will secure beautiful control of the trains and almost absolute immunity from collisions.

Of the possible speed to be reached I will not attempt to say much. I do not think, however, that 100 miles an hour is at all out of the question, for, as we have seen, nearly 90 miles an hour has already been made, and more than 80 is made for short distance by some of the regular express trains between New York and Philadelphia. But consider even what 100 miles an hour means: starting from New York, Philadelphia before breakfast; going northward, Boston an easy morning's run, and finally, perhaps, Chicago a night's trip. All this may sound somewhat fantastic to those of you who have not followed the electrical progress of the last year; but such developments are not only possible but probable. It is not so much a question of whether it can be done, as who will be the first to accomplish it. It may not be for a decade, but unless some strange series of fatalities shall intervene, I see no reason why many of this audience should not take frequent rides on just such a train as I have endeavoured to describe. The first attempt will surely be made ere long, and in the swift progress of electrical matters that first experiment, whether it should fail or not, will surely be followed with ultimate success. Ten years has seen the electric road pass from a plaything at which scoffers turned up their sceptical noses to an everyday necessity. Ten years more will see it pass from the street car of to-day to—who knows what?

NEW PATENTS—1890.

9773. "A system for working punkahs by electricity." R. T. MOORE. Dated June 24.

9780. "Improvements in electric railway signals." W. J. SMITH and J. W. FOX. Dated June 24. (*Complete.*)

9786. "An improvement on electric incandescent lighting, called 'The non-consuming glow light filament.'" L. HENDLE and E. SCHUBERTH. Dated June 24.

9796. "Improvements in and relating to electric circuit controlling apparatus." E. R. GILL, jun. Dated June 24. (*Complete.*)

9797. "Improvements in and relating to electric mechanical combination locks and magnetic power equalisers." W. W. ALEXANDER. Dated June 24. (*Complete.*)

9814. "Improvements in apparatus for electrically firing guns." R. MORRIS. Dated June 24.

9820. "Improvements relating to electric arc lamps." J. KENT. Dated June 24.

9857. "Improvements relating to welding, soldering, brazing, and otherwise working metals by electricity, and to apparatus therefor." M. W. DEWEY. Dated June 25. (*Complete.*)

9887. "Improvements in electrical controlling apparatus for use in connection with torpedoes." S. DE KOJINE. Dated June 25.

9888. "Improvements in connection with electric ships, binnacle, side, and indicator lamps." T. W. WATSON and A. H. WATSON. Dated June 26.

9904. "Improvements in armatures for electrical apparatus such as dynamos, motors, and transformers." W. H. CLARKE. Dated June 26.

9917. "An improved electrical circuit closer." A. M. CLARK. (Communicated by R. O. G. Drummond, South Africa.) Dated June 26.

9956. "Improvements in heating by electricity." R. KENNEDY. Dated June 27.

9991. "Improvements in or connected with the manufacture of iron by electrolysis." T. PARKER. Dated June 27.

10010 "An electrical turn-over time glass." W. PARNALL. Dated June 28.

10025. "Improvements in electric safety fuses." W. M. MORDEY. Dated July 28.

10038. "Improvements in the electrolytic treatment of metals." A. WATT. Dated June 28.

10044. "Improvements in primary batteries and in apparatus connected therewith." Sir C. S. FORBES. Dated June 28.

10064. "Improvements in electric light fittings." T. G. MARSH and G. T. BARLOW. Dated June 30.

10076. "Improved safety connections or couplings for electric conductors." R. H. GOULD and T. GOTTSCHALK. Dated June 30. (*Complete.*)

10090. "Improvements in dynamo and electric motor machinery." J. A. BRIGGS. Dated June 30.

10100. "Improvements in and relating to electrical indicators." A. M. FLACK. Dated June 30.

10122. "Improvements in and relating to heating apparatus for use on electric railways." M. W. DEWEY. Dated June 30.

10123. "Improvements relating to welding, soldering, and otherwise working metals by electricity." M. W. DEWEY. Dated June 30. (*Complete.*) [Date applied for under Patents Act, 1883, Sec. 103, 11th December, 1889, being date of application in United States.]

10124. "Improvements in electric heating apparatus." M. W. DEWEY. Dated June 30. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

6569. "Improvements in dynamo-electric generators and motors." G. E. DORMAN. Dated April 17. 8d. A dynamo-electric generator or motor made according to the invention consists of a cast iron tube, cast in halves, each half being bolted to the other half by means of lugs or flanges cast on the exterior of said half tubes, on the interior of each half tube and centrally located a pole piece being cast, and on the ends of each half tube a bracket or plate being cast, which may partially or completely enclose the ends of its half tube, said brackets containing half of a boss, which when the two half tubes are bolted together is bored out, at the same time or at the same setting at which the pole pieces are bored out, thus ensuring centrality of an armature to be supported between the pole pieces, the shaft of said armature being supported in journals or bushes fixed in aforesaid bosses. Around the pole pieces within said cast iron half tubes are placed exciting coils previously wound and taped, and afterwards bent or compressed in a mould or otherwise to exactly fit the curvature of the interior of the cast iron half tubes around said pole pieces, the coils being made in one, or, for convenience in bending or compressing, in two or more sections, and one or more sections may be larger than the other section or sections in the same coil, the coils thus made as nearly as possible, except where the pole pieces are situate, filling the annular space formed between the armature and cast iron tubes when the machine is put together. 6 claims.

CORRESPONDENCE.

Resistance Measurements.

Under the heading of "The Accurate Measurement of Low Resistances," Mr. Eden puts forth the principle of shunting a resistance to obtain a more accurate adjustment than it is possible to obtain by means of direct alterations in the series resistance of the arm of the Wheatstone bridge as arranged. I do not remember to have seen the method described before in exactly the same manner as in the article above mentioned, but I would point out that the method used by the British Association experimentalists to compare the resistance of the rotating coil used to determine the ohm, and the concrete reproduction of that value was based on a very similar arrangement of high resistance shunts to a low fixed resistance. Also a paper was read some time ago before the Physical Society, by Prof. Fleming, if I remember aright, describing a method of making standard resistance coils based on obtaining a standard nearly correct and adjusting same by means of a higher resistance in shunt. In heavy current work the principle is also very handy, as out of 10 coils in parallel one may be made slightly adjustable to correct to temperature or current density so that the resultant value of the grid resistance remains unchanged. Since the publication of the method in the last issue of the REVIEW, I have tried it in standardising resistances to carry heavy currents and have found a Thomson rheostat of 1,200$^{\omega}$ very handy, the resistance of its wire being taken by the P.O. bridge immediately balance has been obtained.

Charles H. Yeaman, *Electric Inspector.*

Corporation Laboratory, Liverpool,
July 8th, 1890.

Electric Traction.

We notice in your last issue a letter signed F. Baines, in which, when speaking of the exhibition of our new system of electric traction, at the depôt of the West Metropolitan Tramway Company at Chiswick, last Wednesday week, he says: "I am informed by one who was present at the trial that the runs made by the open car extended over a considerable length of track, viz., about 25 *yards*." On the faith of his informant's statement he then goes on to speak of the demonstration as purely a laboratory experiment, &c.

We think it right to inform the public through your columns that the line on which our new system is in operation at Chiswick, and over which the car was run on the occasion in question, is 75 yards in length. It is as long as the space available for it in the depôt, and so far as demonstrating the efficiency of the system and indicating the speed that can be obtained, it is as good as a line a mile long. We shall be happy to invite Mr. Baines to come to Chiswick and see for himself.

For the LINEFF ELECTRIC TRACTION AND LIGHTING SYNDICATE, LIMITED.

Alfred E. Stove, *Secretary.*

July 9th, 1890.

[We fail to see that a line of 75 yards in length is suitable for demonstrating either the efficiency of an electric traction system or the speed which can be obtained. Surely our correspondent cannot think that a locomotive or a steamship would be tested for efficiency or pace on a length of track like the one in question, and we fear his letter is only calculated to damn the syndicate with faint praise.—EDS. ELEC. REV.]